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DISEASES OF TURKEYS

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DISEASES OF TURKEYS[1]

W. R. HINSHAW[2]

Blackhead was considered to be the most important disease of turkeys in California until Graybill[3] showed that other diseases were causing much of the mortality. Subsequent investigations have shown that these losses have many causes, some of which have been studied sufficiently to warrant definite recommendations regarding prevention and control, whereas others are still either undetermined or in need of more research.

This bulletin reports progress on certain turkey-disease problems still being studied at this station. It also brings together previously published data both from this station and from other sources. In the first section will be discussed some general principles of prevention and control, applicable to all diseases. Since prevention is the keynote of disease control, very little space will be devoted to treatment.

Some of the materials listed in this bulletin may become scarce and unavailable because of the war. In such cases, it is suggested that the reader consult his local veterinarian or county farm advisor, or write to the Agricultural Extension Service, University of California, Berkeley, to learn about possible substitutes that may be used. Great caution should be exercised in the use of substitutes unless they have been proved of value for the intended service.

PRINCIPLES OF DISEASE PREVENTION

The same principles of disease prevention apply to turkeys as to other livestock; and they are even, to a large extent, the same as those applying to human beings. Van Es and Olney[4] summarize the factors conducive to health and body efficiency: "(1) soundness of body and of constitution and vigor, (2) adequate nutrition, (3) suitable environment, and (4) eradication and control of transmissible diseases." Although immunity to disease cannot be guaranteed when turkeys are reared according to these principles, the turkey grower who observes them will increase his chances of raising a profitable flock.

[1] Original manuscript received for publication April 15, 1937; the revision, March 19, 1942.

[2] Associate Professor of Veterinary Science and Veterinarian in the Experiment Station.

[3] Graybill, H. W. Blackhead and other causes of loss of turkeys in California. California Agr. Exp. Sta. Cir. 291:1–14. 1925.

[4] Van Es, L., and J. F. Olney. Diseases of poultry—their nature and control. Nebraska Agr. Exp. Sta. Bul. 290:1–110. 1934.

SOUNDNESS OF BODY AND CONSTITUTION

The most important factor in having a flock of sound, vigorous turkeys that have good constitutions is the breeding stock behind the group. Selection of the healthy, well-matured turkeys before selling any of the birds for market will aid in building up a flock free from inherent abnormalities. Birds from a parent that had some defect such as a pendulous crop, crooked toes, or a curved spine should always be avoided. A poult that has come through the season without any setback will serve much better for propagation than one that has had several setbacks. Marking the prospective breeders early in the season for later culling to the number needed insures a large group of birds that meet with the requirements. Before being finally selected for a breeding flock, each individual should be examined for defects and discarded if abnormal in any way.

When buying hatching eggs or day-old poults, one should inquire carefully into the source of the stock to be purchased. To meet increasing competition, hatcheries must furnish the kind of poults required by their customers. The purchaser should therefore demand birds from disease-free breeding flocks that measure up to the standards just discussed.

ADEQUATE NUTRITION

An adequate diet is one that supplies all the essentials for normal growth. With any one essential food lacking or even, in some instances, overabundant, the normal development will be hindered; and a diseased condition, directly or indirectly due to the faulty ration, may result. Whether or not heavy losses from death occur in such cases, slow development may cause as great a monetary loss as if the flock suffered from a heavy mortality. Some of the dietary disorders caused by faulty rations will be discussed under another heading.[5]

SUITABLE ENVIRONMENT

The term "environment" refers to the surroundings in which the turkeys must live. Necessarily, this environment varies with the methods of rearing. The practice used in some sections of California of hatching and rearing with turkey hens on large range areas furnishes an entirely different type of environment from that furnished by the so-called "artificial" method of incubator hatching of eggs and brooder rearing of poults. Furthermore, this range rearing of poults is in contrast to the confinement method.

[5] For information concerning rations found suitable for turkey rearing, the reader is referred to: Asmundson, V. S., and T. H. Jukes. Turkey production in California. California Agr. Ext. Cir. 110:1–78. 1939.

In any case, the relation to disease depends on the ability of the environment to aid nature in combating disease. Dryness, drainage, amount of sunshine, nearness to chickens or other fowls on the same ranch, location in respect to other ranches, type of soil, and shelter facilities are examples of environmental factors that may influence the disease problem on any turkey ranch.

ERADICATION AND CONTROL OF TRANSMISSIBLE DISEASES

Transmissible diseases are those commonly called infectious or contagious. Once established, they may cause heavy losses. Examples are blackhead, fowl typhoid, fowl cholera, pullorum disease, paratyphoid, and coccidiosis. Each infectious disease has its specific germ, which must be introduced into the body of a susceptible bird before it can cause the disease. The two general ways of introducing such diseases into a flock are natural and mechanical carriers.

Natural Carriers.—The most serious carriers of infections are turkeys or other animals which have apparently recovered from the disease in question but which still retain the germs in some part of the body where they continue to multiply and to be eliminated. The diseases known to be transmitted by apparently normal carriers include blackhead, coccidiosis, fowl typhoid, infectious catarrhal enteritis, and pullorum disease. Removing natural carriers from the flock and premises is the most effective way of preventing a recurrence of an outbreak. Different methods of accomplishing this end exist; *but one, common to all diseases, is absolute isolation of the adult breeding flock from the growing flock.*

Disposing of all the turkeys on the premises and buying day-old poults from reliable hatcheries for each year's flock is an excellent method of eliminating natural carriers. Such a system of management necessitates a division of the turkey industry into two classes: the utility, or meat-producing, and the breeding. This division will be for the betterment of the turkey industry; the meat producer will be able to obtain a better class of poults from the breeder who makes it his business to improve his stock constantly.

The producer of hatching eggs will have the problem of isolating from his adult flock and other fowl the poults kept for replacements. Brooding of poults with turkey hens is conducive to disease spread, since a carrier hen is a continual source of the infection. Coccidiosis and blackhead, for example, are impossible to control if infected turkey hens are used to brood poults. No matter what sanitary precautions are taken to prevent these diseases in turkey-hen-reared poults, the continual elimination of germs by the mother hen will defeat the sanitary methods used.

Unfortunately, carriers of the more common diseases of turkeys cannot be detected by simplified tests that are practicable. The agglutination tests for carriers of fowl typhoid and of pullorum disease are exceptions. The tuberculin test for detecting tuberculosis carriers, though reliable for chickens and other livestock, has not proved efficient for turkeys.

Chickens may be carriers of many diseases common to both turkeys and chickens. In some instances—for example, in blackhead—they are fairly resistant, whereas turkeys are highly susceptible. Turkeys and chickens can be successfully reared as penmates or in adjoining yards provided both species are free of disease; but the chances that chickens may carry blackhead or other diseases are too great to risk.

Mechanical Carriers.—Mechanical carriers include all means by which germs are accidentally carried from place to place: man, animals, wild birds, insects, dust storms, moving vehicles, and flowing streams. Disease prevention includes the prevention of infection by such carriers.

Man is the worst offender. The attendant who cares for a flock of adult turkeys that contains coccidiosis carriers is the principal carrier of the disease to young poults. As experimental work at this station has shown, an attendant may carry coccidia on the soles of his shoes at least ½ mile. Sterilized feed trodden by attendants who have visited yards known to contain coccidiosis carriers has proved to be contaminated and, when given to susceptible birds, has produced fatal cases of coccidiosis. Thus, if adult turkeys are to be kept on the same ranch with poults, great care must be taken to prevent spread of the disease from the adults to the poults by attendants. This precaution applies also to other diseases.

Visitors, especially other turkey growers, feed salesmen, and service men, are the principal offenders aside from the attendant himself. The turkey grower should avoid visiting his neighbor's ranch if disease is known to be present. Visitors should be cautioned about entering the houses and yards. The feed dealer's or the poultry buyer's truck and the borrowed spray tank that has been making the rounds of the turkey ranches may be sources of disease. So are also the used feed sack, the poultry crate that has not been thoroughly cleaned and disinfected after being sent to market, and the hoe or scraper that is used in the pens of carriers and then in the brooder house without being cleaned.

Since carcasses and offal from birds killed for table use can be classed as possible sources of infection, such material should be burned or buried deep. Contaminated soil and water polluted by sick birds, thrown into streams even at some distance from the ranch, are other sources.

Hospitals and hospital yards may be important in spreading disease to different pens or houses on a ranch. Sick birds from several pens

congregated in one hospital pen or house and later taken back to their respective quarters may not only carry back the condition for which they were removed but, in addition, one or more diseases contracted while in the hospital. For this reason hospital pens are not advocated. Birds removed for treatment should be kept near their respective units.

Wild birds, dogs, cats, rodents, and insects are difficult to incriminate as mechanical carriers, but they are possibilities and should be kept away from rearing quarters whenever possible. Certain wild birds susceptible to turkey diseases are potential natural carriers.

If chickens are reared on the same ranch with turkeys, care should be taken to reduce to a minimum the possibility of infection of one species by the other. An irrigation ditch running from a chicken yard to a turkey yard is a common method of spreading disease. Equally dangerous is the ditch or stream passing through one poultry ranch and flowing through the turkey pens of an adjoining ranch.

SANITATION

Sanitation may be defined as the means and measures directed toward establishing and maintaining an environment in which it is possible for animals to live a healthy existence. The factors considered on the preceding pages have important bearing on any sanitary program—especially the elimination of carriers. Other factors to consider are houses, yards, water supplies, and food.

Houses and Yards.—The first step in the sanitation of brooder houses is the original design and construction. Ease of cleaning and disinfection, proper isolation of each unit in case of the multiple-pen type, separate entrances for each unit, sanitary water and feeding systems, rodentproof feed storage containers, and proper ventilation should be considered when building a brooder house. Continuous with the cement floors of the houses, cement yards should be constructed with sides and with the proper slope to permit cleaning and washing of one pen without danger of getting water and refuse into the adjoining pens. Facilities for cleaning the individual houses and yards can be arranged by having a gate in the front entrance of each yard. A gravel drainage area in front of the yard system or a cement drain to take off the excess water after washing the yards is desirable.

Wire sun porches and wire platforms are also an aid in preventing disease, if intelligently used. More often than not they are, however, both misconstructed and misused. Common faults in construction are: (1) excessive width, (2) wire of too small mesh and gauge, (3) improper installation of feed and water containers, (4) improper height from the ground, (5) improper facilities for collecting and removing droppings,

and (6) failure to make sides and top birdproof. Examples of misuse are: (1) improper cleaning, (2) attendants walking on platforms to fill feeders and waterers or to catch birds, (3) overcrowding, (4) contamination of pens by placing dirty utensils on platforms, and (5) use of cleaning utensils for all age groups without cleaning and disinfecting between pens.

The number of birds on a given area, either in the brooder house or on the range, may influence the livability percentage to a marked degree. Overcrowding means more work in keeping the surroundings clean and dry; it also increases the problem of feeding and ventilation in brooders. These factors indirectly lower the resistance of birds and facilitate spread of disease.

Yards or ranges for growing turkeys should be maintained free of all infections and infestations. Chickens should never be reared alternately in yards with turkeys. For the confinement method of rearing turkeys, rotation of runs is recommended. In large range areas, as used in some sections of the state, rotation of runs is impossible; but feeding grounds and feeding areas can be moved at least twice a week as an aid in preventing accumulations of manure and litter, where the greatest danger of disease lies. Good drainage that prevents the formation of stagnant pools in yards is necessary. The probability of introducing disease is directly related to the amount of parasitic invasion. If moisture is not present, only the more resistant organisms can remain alive and infective. Good drainage, such as is found on sandy or gravelly soil, aids in keeping infections at a minimum, because of the dilution factor of rains. Dry, hot weather with an abundance of sunshine, such as exists in many California areas, aids in reducing the possibility of contamination and therefore in preventing disease. The range method, which provides enough ground so that birds can be moved frequently to clean areas, likewise helps.

Water Supply.—Since the water supply is no better than the poorest water available, all sources other than those known to be clean and safe from contamination should be removed. The best type of water fountain is of no value in preventing disease if it is allowed to overflow and to form a stagnant pool. The immediate area around the permanent fountain or drinking place should be filled in for several inches with gravel; or the container should be set on a screened platform to insure a dry area, which will help to prevent the spread of disease. In houses or in yards, wherever possible, an automatic watering system with proper drainage for disposal of the surplus is recommended. Figure 1 illustrates types of watering devices that are acceptable. Many other types of ready-made sanitary water equipment are on the market.

Streams and irrigation ditches as a source of water are safe, provided they come from uncontaminated sources, are not stagnant, and are flowing at a fair rate of speed. *Pools of stagnant water from overflowing or leaking canals or water from ditches that are not flowing cannot be considered reliable.* Since poisoning from salt water and alkali water has been reported, such waters should always be avoided.

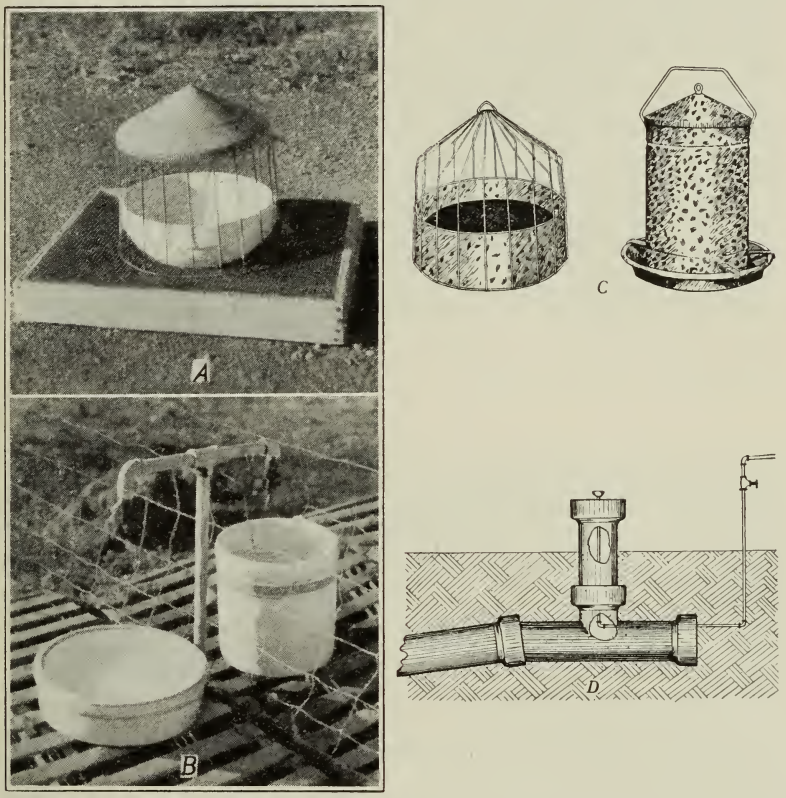

Fig. 1.—*A*, A sanitary type of waterer; placing the watering device on a wire platform aids in preventing spread of disease. *B*, A sanitary watering system for use with running water; the overflow passes into a drainage pit below the lath platform. *C*, Two types of commercially made galvanized waterers suitable for poults; these should be set on wire platforms (as in *A*) to insure dry surroundings. *D*, The "Van Es" type of water fountain; it provides for a continuous flow of water in the bubbler and for passage of overflow into the tile drain. The drinking cup is placed 8 inches above the ground, is kept automatically cleansed, and can be regarded as strictly sanitary. (*D*, Courtesy of L. Van Es, University of Nebraska.)

Pure, fresh, clean water is the most palatable. If well protected from contamination by body wastes, soil, and feed, it far surpasses the same water doped with panaceas. Birds do not like most of the common anti-

septics recommended for drinking water; often they avoid water because of this dislike. Frequent changing of water or the use of a sanitary drip or cup system is preferable to the use of antiseptics.

Feeds and Feeding Methods.—Feed as a mechanical means of carrying infection has already been mentioned. In addition, feed may directly transmit fungus diseases, botulism, and possibly paratyphoid infections. For these reasons, one should purchase the best feed and protect it from

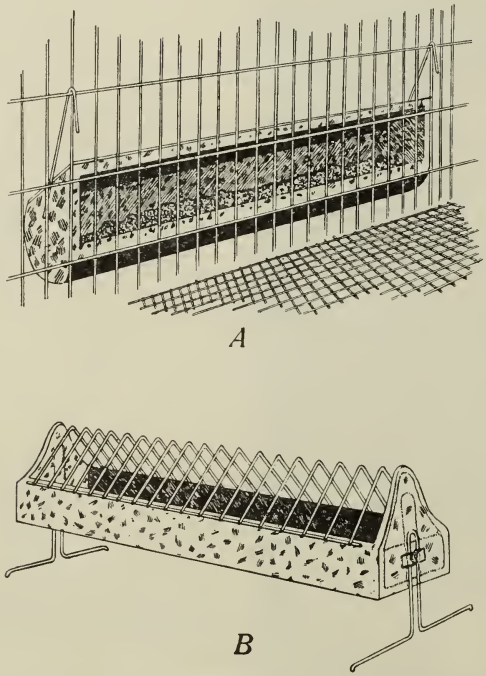

Fig. 2.—*A*, This practical type of metal feeder is designed for hanging on the outside of the wire-fence enclosure of a wire-floored sun porch. It can be filled without going into the pen. *B*, A type of metal feed hopper with wire guards that aid in keeping the feed clean. Note that this type of feeder can be raised or lowered to accommodate different sizes of birds.

dampness and from all sources of infection. Moldy feed should never be given to turkeys.

Several outbreaks of mycosis originating from contaminated milk containers have been observed by the author. Failure to wash and scald daily the cans used for transporting milk from the dairy to the turkey range has been the most common cause. Improper care of semisolid milk has been another source of mycosis.

Safeguarding the feed against fecal matter and other refuse by using properly constructed feed hoppers is a necessary procedure in the sani-

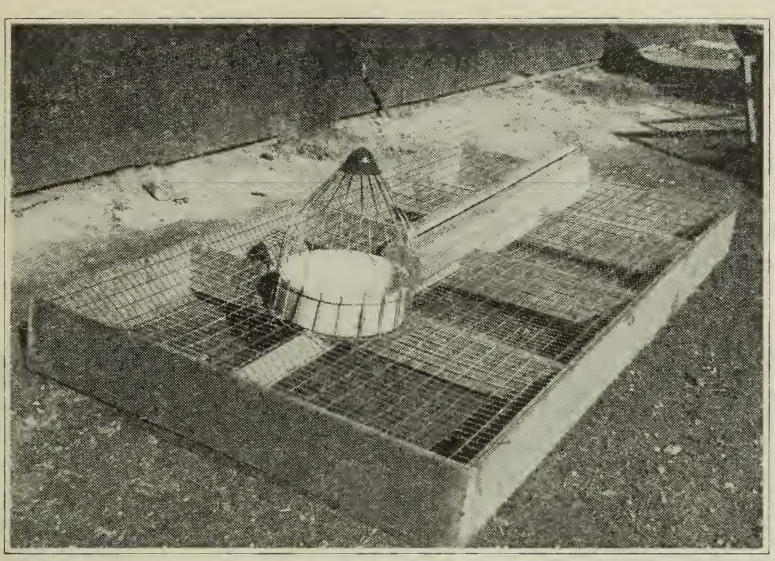

Fig. 3.—Wire platform with feeder and waterers. Note the height of the platform, the size of wire mesh, and the ample space for birds. This allows the majority of the droppings to be deposited inside the platform. (Courtesy Los Angeles County Poultry Demonstration Plant.)

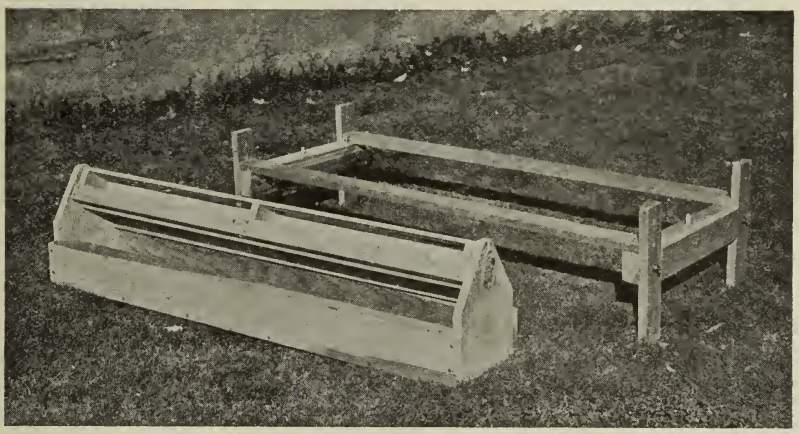

Fig. 4.—An open-type feed hopper for growing poults. A swivel-type cross-piece prevents roosting on the hooper. (From Bul. 476.)

tary program; and cleaning the hoppers scrupulously at frequent intervals is important. *Sweepings from the floor of the feed house should never be given to young growing stock,* because of the danger of refuse carried from the adult flock on the attendants' clothing and shoes. If feed is mixed on the ranch, mechanical mixing is much superior to hand-mixing and reduces the chance for accidental contaminations. Feed

hoppers that aid in preventing disease are shown in figures 2 to 5. Many suitable types of metal hoppers are on the market.

Excess feed scattered around yards attracts rats, mice, and birds, which are all potential carriers of disease. Proper storage of feed in rat- and mouseproof bins will aid in disease control. Sacked feed that must be stored can be kept reasonably free from these rodent pests by careful attention to ratproofing storage houses.[6] Metal garbage cans with covers make suitable bins for temporary storage of feed in brooder houses and in yards. These should be placed outside of the yards whenever possible.

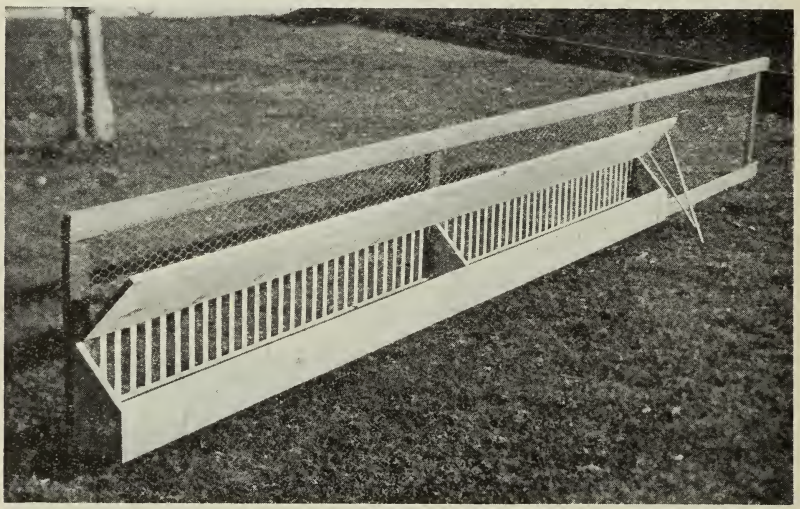

Fig. 5.—Feeder for grain, mash, or chopped greens. It has the advantage of permitting feeding from the outside of the pen. (From Ext. Cir. 58.)

DISINFECTION AND DISINFESTATION

Disinfection destroys the microbic causes of diseases; disinfestation, the higher forms of life that are causes of disease. Destruction of coccidia, of pullorum-disease germs, and of blackhead germs are examples of disinfection. Lice, ticks, and worm eggs are disease-producing parasites whose destruction comes under the head of disinfestation. The products used for destroying organisms are known as disinfectants and disinfestants according to their use; and in a sanitary program for controlling turkey diseases, they are used principally to destroy parasites outside of, or on the body of, the host. Eliminating the host is the only

[6] The principles of rat and mouse control are given in: Storer, T. I., Control of injurious rodents in California. California Agr. Ext. Cir. 79:1–62. 1933. Revised 1942.

Methods for rat-proofing buildings and premises may be found in: Silver, James, W. E. Crouch, and M. C. Betts. Rat-proofing buildings and premises. U. S. Dept. Agr. Farmers' Bul. 1638:1–26. 1930.

effective means of freeing flocks from the parasites harbored within the body of the carrier. Remedies for removing parasites from within the body of the host cannot be considered here, since one can rarely eliminate and destroy all the parasites by treatment.

Disinfection.—Disinfection is important in reducing the amount of infection in flocks where carriers exist and, after an outbreak of disease, in destroying the enormous numbers of parasites eliminated. Disinfection at frequent intervals during an outbreak helps to reduce the amount of infection and thus to prevent further spread. It may be accomplished by mechanical, physical, or chemical means. Success depends on the nature of the environment, the character of the disease germs to be destroyed, and the method to be used. The procedure must fit the special conditions on the ranch. In most cases a combination of the three means gives the best results.

Cleaning, before the final application of chemicals, is essential in any disinfection program. Used alone, it will not result in disinfection; but, if carried out properly, it will reduce the number of germs and will render disinfection by chemicals more efficient. Water or weak soapsuds used to flush the walls of a brooder house may serve, however, as a medium for growth of germs and, unless collected and not allowed to run over the ground, may spread infection. The following steps are suggested for cleaning and disinfecting brooder houses and cement runs before poults are put in them:

1. Settle the dust by spraying lightly with the disinfectant to be used. This procedure avoids undue scattering of germs by the dust.

2. Haul all litter and droppings to a well-isolated portion of the ranch where there will be no danger of contact with the turkeys. Never spread litter or droppings on the land being used for ranging turkeys or chickens. If infection is known to exist, burn the litter.

3. Remove all movable equipment to the cement run or to a cleaning floor or platform if one is available.

4. Scrub the walls, floors, and equipment with hot lye solution made by adding 1 pound of lye to 20 gallons of hot water. An old broom can be used to apply this solution; care should be taken to prevent the fluid from getting on the hands and face. About 1 hour after its application, the lye should be rinsed off with hot water.

5. Spray the walls, floors, and all equipment with a good disinfectant of the concentration recommended by the manufacturer. Use a compressed air sprayer for applying the disinfectant, and cover every part of the building or equipment.

6. Allow time for drying before putting the house and equipment into use again. The fire gun may be an aid in drying if the time is limited.

Certain types of hovers and brooder-heating equipment are not easily washed and disinfected by this method because of the danger of injuring them. The formaldehyde gas method recommended for disinfecting cabinet types of incubators may be used for such equipment if a gas-proof room is available.

The recommendations given above should be followed each time a brood of poults is removed from a pen and before a new lot is added. The same methods are helpful in cleaning and disinfecting any house used for poultry.

After the poults are put in the brooder house, frequent dry cleaning without disinfection is sufficient. This procedure is recommended because moisture promotes the development of coccidia, the cause of coccidiosis. The fire gun may be an aid in drying up areas around water fountains and feed hoppers. (See "Dry Heat," p. 21.)

Disinfestation.—Mechanical or physical means of hindering the development of parasites or destroying them are probably as important as chemical means. Cleaning the yards of all refuse, removing litter and droppings frequently, and constructing the houses so as to prevent the harboring of ticks, lice, and mites are examples of mechanical methods. All methods of fly control—trapping, cleanliness, and removal of breeding places—indirectly aid in tapeworm disinfestation. Oil sprays for mite and tick control and nicotine sulfate or sodium fluoride for lice are chemical means of destroying parasites.

The methods recommended for cleaning and disinfection are also applicable in the disinfestation program. Yards are best treated by frequent cleaning and by rotation. The former dilutes the amount of infection or infestation and allows the sun better opportunity to exert its influence on the remaining parasites. Rotation of runs at regular intervals allows the sun and the other natural elements to free a given area of parasites and disease germs. No satisfactory cheap disinfestant for the soil has been found.

Plowing of the yards is not recommended under California conditions unless necessary for weed control or unless a crop-rotation system is combined with the turkey-rearing program. Plowed yards soon become dusty, tend to become jutted with holes that collect water during rains, and are harder to clean than yards that are left unplowed.

DISINFECTANTS

The number of chemicals sold as disinfectants is so great that the prospective buyer is often bewildered when he goes to purchase a supply. Some are worthless; others are excellent disinfectants but have undesirable characteristics. Among the properties of an ideal chemical for

this purpose are: (1) low cost per unit of disinfecting value, (2) ready solubility in hard water, (3) relative safety to man and animals, (4) efficient deodorization, (5) easy availability, (6) nondestructibility to utensils and fabrics, (7) stability when exposed to air, (8) absence or minimum of objectionable and lingering odor, (9) effectiveness for a large variety of germs. Obviously, no one chemical will have all these properties; but the list will serve as a guide. Though far from being a satisfactory means of evaluating a product, the phenol coefficient gives one a fair estimate of its effectiveness.

Many disinfectants of similar composition are sold under different trade names. Before buying a product under an unfamiliar trade name, one should compare types and values with a well-known product. The directions for dilution given by the manufacturer should be followed in making up a preparation for use. These directions are usually based on the concentration of the product; and by comparing the dilution factor of two disinfectants that have other properties equal, one can determine the relative cost of the two. For instance, if one disinfectant can be used at the rate of 1 part to 40 parts of water, while another has to be used at the rate of 1 part to 20 parts of water, the first, other things being equal, is worth twice as much as the second.

Water is the most effective diluent for disinfectants. Crude oil, or distillate, or similar oil products should never be used for diluting disinfectants, because oil lowers the disinfecting value.

Phenol, or Carbolic Acid.—Phenol is a chemical substance obtained from coal tar. In its pure form it occurs as colorless needles having a characteristic odor familiar to everyone. It is usually sold in water solutions and is too expensive for general use. A 2 per cent solution is a useful antiseptic for wounds; but stronger solutions, as a rule, are caustic. This is the chemical used as a basis for determining the phenol coefficient of disinfectants.

Crude Carbolic Acid.—Crude carbolic acid is a mixture of phenol, cresol, and certain impurities. Its usefulness varies directly with the percentage of cresol, which has a higher disinfecting value than phenol. Since its composition is uncertain, it cannot be classed as a desirable disinfectant for general farm use. *It is sometimes used in oil mixtures for controlling mites and lice in poultry houses; but, since the oil is as effective without the crude carbolic acid, there is no reason for combining the two.*

Cresol.—Cresol is a thick, yellow or brown liquid, mixable with water but only slightly soluble. It forms the basis for a large number of the best commercial brands of disinfectants, made by combining cresol with a soap base.

Compound solution of cresol (liquor cresolis compositus U.S.P.), the most refined of the saponified cresol solutions, is composed of cresol 500 grams, linseed oil 350 grams, potassium hydrate 80 grams, and water to make 1,000 grams. Saponified cresol solutions are more effective and less toxic than phenol, can be used in low-percentage solutions, are reasonably priced, and are fairly stable in the presence of organic matter; but they have the disadvantage of being soapy and of having the odor characteristic of the cresols. They can be recommended for general use on the farm.

Turkey growers who need large quantities of disinfectants would do well to buy them to conform with the specifications of the United States Department of Agriculture Bureau of Animal Industry.[7] Saponified cresol solutions applied under supervision of the Bureau must contain not less than 50 nor more than 53 per cent total phenol and not less than 21 per cent by weight of soap; they must form clear solutions when mixed with water, and must be used in the proportions of 4 fluid ounces per gallon of water.

Coal-Tar Disinfectants (Sheep-Dips).—Coal-tar disinfectants are cresol products that form milky emulsions when mixed with water. They vary greatly in their solubility and disinfecting value and when used should be diluted according to the directions given by the manufacturer.

Chlorine Gas.—Chlorine gas is the basis of the disinfectants known as hypochlorites. The numerous brands of these products offered for sale vary in their disinfecting value according to their chlorine stability and their ability to liberate chlorine gas. They should contain at least 2.6 per cent by weight of available chlorine, the active disinfecting element of such products. Such solutions, if used according to directions, are highly efficient. Their chief disadvantage is the instability of the chlorine when exposed to air or organic matter. They are also expensive. Their principal use is for disinfecting limited areas such as incubators, small brooders, and water and feed containers. *All surfaces to be disinfected with hypochlorite solutions must first be thoroughly cleaned in order to insure the greatest efficiency. Stock supplies should be kept in dark, cool places, and the containers should be tightly sealed when not in use.*

Chlorinated Lime.—Chlorinated lime, known as bleaching powder, is prepared by saturating slaked lime with chlorine gas. It should con-

[7] The disinfectants recognized for official use are listed in: Mohler, J. R. Permitted disinfectants, revised list 1940. U. S. Dept. Agr. Bur. Anim. Indus. Cir. Letter 2220:1–4. (Mimeo.) This may be obtained by writing to the United States Department of Agriculture Bureau of Animal Industry, Washington, D. C.

A list of the disinfectants offered for sale within the state, with their analyses, can be obtained from the Division of Chemistry, State Department of Agriculture, Sacramento, California.

tain from 30 to 35 per cent of available chlorine. The Bureau of Animal Industry recognizes chlorinated lime containing at least 30 per cent available chlorine for official disinfection when used in proportions of 1 pound to 3 gallons of water. Products containing less available chlorine should be used in more concentrated solutions. The final dilution should contain approximately 1.2 per cent of available chlorine by weight. Fresh solutions must be prepared daily. All products containing chlorine must be handled with care, for free chlorine is destructive to fabrics, leather, and metal.

The use of chlorine on the turkey ranch is limited to disinfection of drains, water containers, and feed containers. Its instability makes it of doubtful value for general disinfection.

Quicklime (*Unslaked Lime, Calcium Oxide*).—The action of quicklime depends on the liberation of heat and oxygen when the chemical comes in contact with water. On the poultry ranch its use is limited to small yard areas that are damp and cannot be given a sunning, to the disinfection of drains and fecal matter, and to whitewashes. Adding chlorinated lime to quicklime at the rate of 1 pound to 40 gallons of wash increases its disinfecting value in whitewashes.

As quicklime has a caustic action, turkeys should be kept away from it until it has become thoroughly dry.

Lye.—Lye is an excellent cleaning agent, valuable in any disinfecting program. A 2 per cent solution of sodium hydroxide (soda lye) is a good disinfectant for many of the germs causing disease. Because of insufficient data on its disinfecting value against some of the common poultry-disease germs, however, it should be used primarily as a preliminary cleaning agent. Being a severe caustic, it should be handled with care.

Formaldehyde.—Formaldehyde is a gas, sold commercially in a 40 per cent solution with water under the name of formalin. For spraying, it is used in a 10 per cent solution of formalin (that is, a 4 per cent solution of formaldehyde). Though a powerful disinfectant, it has many disadvantages, especially its volatility, penetrating odor, caustic action, and tendency to harden the skin—properties which make it disagreeable to apply. Its chief advantages are as follows: (1) it can be used as a gas or vapor for fumigation of incubators or small rooms; (2) it is relatively nontoxic to animals and fowls; (3) it is an efficient disinfectant in the presence of organic matter; and (4) it does not injure utensils and spraying equipment with which it comes in contact.

Its use on the turkey ranch is limited to disinfection of brooder equipment, incubators, water and feed containers, and occasionally—during outbreaks—fumigation of clothing and small utensils that are difficult

to disinfect by other means. Fumigation of brooder houses with formaldehyde is, as a rule, impractical because of the difficulty in getting them airtight.

Fumigation of incubators and incubator rooms is a practical procedure, in common use by hatcherymen. Most manufacturers have recommendations for their type of machine; and, when possible, their directions should be followed. When fumigating a room or an incubator, one must have the space airtight and the room temperature and humidity as high as possible. For most efficient disinfection of incubators, Bushnell and Payne[8] recommend a wet-bulb thermometer reading of 85° to 95° F. Disinfection is uncertain in rooms having a temperature of less than 65° and a relative humidity of less than 60 per cent.

The two common methods of fumigating cabinet-type incubators (forced- or circulating-air types) are given below:

1. Formaldehyde gas is generated by mixing formalin (40 per cent formaldehyde) and potassium permanganate. For this purpose 35 cubic centimeters of commercial formalin and 17.5 grams of potassium permanganate for each 100 cubic feet of incubator space are mixed together in an earthenware or enamelware vessel having a volume of four to five times the amount of material used. The vessel should be placed about 3 feet above the floor in the middle compartment of the incubator. The doors should be kept closed for at least 10 minutes to allow the gas to penetrate to all parts of the machine. Equipment for generating and introducing the gas through the intake parts of certain types of machines is obtainable from the manufacturers.

Compartment-type (still-air type) machines do not lend themselves to fumigation methods so well as do the cabinet types, but can be so disinfected by opening them and fumigating the room in which they are located.

2. Formaldehyde gas liberated from formalin-soaked cheesecloth is recommended by the Illinois Agricultural Experiment Station.[9] Before disinfection, the incubator must be thoroughly dry-cleaned. Approximately 20 cubic centimeters of formalin is used for each 100 cubic feet of incubator space. A saturated cloth large enough to carry the formalin without dripping is suspended under or near the circulating fans, and the formalin allowed to evaporate. This method is said to be as efficient as the first and is less expensive.

Formaldehyde can be successfully used when eggs are in the incubator, without injury to the eggs. It is therefore of especial value for

[8] Bushnell, L. D., and L. F. Payne. Dissemination of pullorum disease in the incubator. Kansas Agr. Exp. Sta. Tech. Bul. 29:1–60. 1931.

[9] Graham, R., and Viola M. Michael. Incubator hygiene in the control of pullorum disease. Illinois Agr. Exp. Sta. Cir. 403:1–16. 1933.

disinfecting between hatches in large incubators where poults are hatching at short intervals of time. Fumigation with formaldehyde kills the common disease germs in the incubator, but not within the egg nor within the body of the hatching poult. Its principal use, therefore, is in disinfecting incubators between hatches and, in some instances, during the early stages of a hatch. Before fumigation of incubators during the hatching period, advice should be sought from one familiar with the procedure, to determine the possible need and methods. In general, fumigation of hatching poults is not recommended.

Copper Sulfate (Bluestone).—Although copper sulfate and other salts of copper have a marked poisonous effect upon some of the lower forms of life, they are not considered good general disinfectants. Copper sulfate is a good destroyer of algae and certain fungi and may prove of some value in outbreaks of fungus diseases. As experimental work done at this station has shown, copper sulfate of a greater concentration than 1 part in 500 of water may be toxic when given as the only source of drinking water. Turkeys do not like copper sulfate solutions of any concentration and will seek other water supplies if they are available. A 0.5 per cent solution may be of value for disinfecting feed hoppers, water fountains, and areas around these in fungus-disease outbreaks.

A convenient method of making up approximately a 1–2,000 dilution of copper sulfate solution is given below.

Stock solution: Dissolve 1 pound of copper sulfate (bluestone) in 1 gallon of soft water (rain water or distilled water). If soft water is not available add 1 teaspoon of concentrated hydrochloric acid or 1 cup of vinegar to the water before adding the copper sulfate. It may be necessary to heat the mixture to dissolve the copper sulfate. Store in a glass bottle.

To make a 1–2,000 dilution: Add 1 tablespoon of the stock solution to each gallon of water. It is necessary to acidify hard water by adding just enough vinegar or hydrochloric acid to prevent precipitation of the copper. The amount of acid will vary with the hardness of the water. Not over 1 teaspoon of hydrochloric acid should be added to each gallon of water.

Copper sulfate should not be chosen either for general disinfecting purposes or for use in drinking water except when recommended by a veterinarian or a diagnostic laboratory for controlling a specific disease which has been definitely diagnosed.

Potassium Permanganate.—Potassium permanganate depends on its rapid oxidizing property for its disinfecting value. Although it has little usefulness as a general disinfectant, certain properties make it

convenient as an antiseptic for drinking water. It is inexpensive; and when it has lost its disinfecting power, it turns brown. As it corrodes metals, it must be used in earthenware or wooden vessels. One level teaspoon of potassium permanganate for each gallon of water will aid in reducing the chance for the spread of disease, but it has no medicinal value. Potassium permanganate solutions lose their antiseptic power so quickly in the presence of organic matter that they are useless for mouth or crop treatment.

Sodium Orthophenylphenate.—This substance has only recently been recommended as a general disinfectant. It has no objectionable odor, is relatively nontoxic, is highly efficient for most disease germs, and is readily soluble in water. It may be purchased in the form of a grayish, brownish, or white powder or flakes, which must be kept in a closed container to prevent deterioration. It is now sold under several trade names, which are included under the Bureau of Animal Industry list of permitted disinfectants. It gives best results when applied hot.

Iodine.—This disinfectant, though effective, is too expensive for general use. Tincture of iodine is a valuable antiseptic for skin wounds but should not be used internally.

Iodine suspensoid, a colloidal iodine suspension in water, has been reported by the Michigan Agricultural Experiment Station to be effective against bacteria, coccidia, and worm eggs. It is recommended by the manufacturer for disinfecting brooder-house floors and equipment. Its use, however, is limited because of its high cost. Since iodine preparations, like many other good disinfectants, are quickly destroyed in the presence of organic matter, a thorough cleaning must precede their use.

Mercuric Chloride (Bichloride of Mercury, Corrosive Sublimate).—Although a powerful disinfectant, mercuric chloride is limited in usefulness by its cost, toxicity, and marked corrosive action on metals. It is commonly used in a 1–1,000 dilution with water. Because its value is markedly lowered by the presence of organic matter and because it has certain other undesirable properties, it cannot be recommended for disinfection of litter or houses. Many other disinfectants, almost as efficient and less poisonous, are preferable for use on the turkey ranch.

Sunlight.—The sun's direct rays are the best disinfectant known. Since, however, the material to be treated must be in thin layers and exposed to the direct rays, this method of disinfection is limited to yards and to utensils that can be thoroughly cleaned before being exposed. The construction of most poultry houses prevents efficient disinfection by the sun. A cement platform fully exposed to the rays makes a convenient place for treating movable equipment. If constructed with a drain, it can serve as a washing and disinfection rack.

Use of Hot Water.—Hot water adds to the efficiency of any disinfectant and, if applied in the form of boiling water or live steam, is effective without the addition of any chemical. Live steam must be applied directly to the part to be disinfected.

Use of Dry Heat.—Dry heat in the form of a flame is effective provided the flame comes into contact with the germ to be killed. According to experiments by Stafseth and Camargo,[10] the fire guns commonly used on poultry farms are not highly efficient as a means of disinfection. They may be of some value in drying up the floors and walls after the use of watery solutions of disinfectants and also in drying up damp areas around water and feed containers after a dry cleaning of brooder-house floors. *All methods involving direct flame are, however, dangerous fire hazards.*

DISINFESTANTS

Disinfestants, sometimes called parasiticides, destroy animal parasites such as lice, mites, ticks, and fleas. Their use is recommended only as an adjunct to a properly conducted sanitary control program. Many disinfectants are also destructive to lice, mites, and other similar parasites, provided they come in contact with the parasite. Many, however, are useless as disinfestants.

Crude Oil, Distillates, and Similar Cheap Oils.—Petroleum oils are excellent and cheap destroyers of lice, mites, and ticks. There is no advantage in adding disinfectants to oils for lice and mite control; the oil itself is as effective, and oil lowers the value of a disinfectant. Since the oil must come into direct contact with the parasite, refuse must be removed and all hiding places made accessible before the application.

Carbolineum, a commercial product with good penetrating properties, is very effective for controlling mites and lice within the poultry house. Creosote oils of the penetrating types used for termite control are helpful in lice, tick, and mite control if not too expensive.

Nicotine Sulfate.—A 40 per cent solution of nicotine sulfate, such as is sold under the trade name of Black Leaf 40, is in general use for control of lice on chickens. Its action depends on a volatile substance that penetrates the feathers of the birds when it is painted on the perches just before they go to roost. The method is not well adapted to control of lice on turkeys under California rearing conditions, where the perches are usually placed out of doors.

Sodium Fluoride.—This, either as a dust or as a dip, is effective for ridding birds of lice. For use on turkeys, the dusting method is probably the most desirable. It consists of rubbing a pinch or two of the powder

[10] Stafseth, H. J., and F. Camargo. On the disinfection of poultry houses by means of fire guns. Amer. Vet. Med. Assoc. Jour. 86:162–67. 1935.

into the parts most often infested with lice (on the tail, under the wings, on the neck and head, and on the breast). Such treatments should be repeated in about 2 weeks if the birds are badly infested. Turkey hens used for hatching and brooding poults should be treated before being placed on the eggs and again just before the eggs hatch.

REMEDIES

The most successful turkey growers are those who feed adequate diets consisting of simple ingredients, give the birds all the fresh, pure water they will drink, and spend little or no money for panaceas. The number of specific and useful remedies is limited, and turkey growers should question the merits of advertising literature. The United States Food and Drug Administration has published the following list of turkey diseases for which there is no commonly known specific remedy: fowl typhoid, fowl cholera, fowl pox, coccidiosis, pullorum disease, sinusitis (roup, swell head), and blackhead. Salesmen who try to sell remedies for these diseases should have their attention called to this fact.

The periodic use of laxatives such as Epsom salts is of questionable value. Too often growers who believe that medication of drinking water and the use of Epsom salts at frequent intervals are necessary to maintain the health of their birds overlook certain fundamental principles of feeding, watering, and management which, if carefully observed, would usually eliminate the need for medication.

Dual-purpose worm remedies that are claimed to be efficient for both roundworms and tapeworms have no place in the turkey-management scheme in California, because roundworms in turkeys are of uncommon occurrence in this state. A flock should never be treated for any species of worms until a large number of the birds have been examined. A few worms in one or two birds do not justify treatment. In no case should tapeworm remedies be given to the entire flock before testing out the drug on a few birds. This is necessary because most tapeworm remedies contain kamala, which varies in its toxicity for turkeys.

The giving of remedies should be supervised by someone adequately trained in the art of treatment rather than by the average feed salesman, remedy salesman, or others with little or no training in veterinary medicine. Remedies of merit are listed under the treatment of the specific disease for which they are recommended. They should not be used for other diseases unless advised. A few specifics are available. These include: nicotine products for roundworms, lice, and tropical mites; phenothiazine for cecum worms; sodium fluoride for lice; silver nitrate, argyrol, and similar silver preparations for infectious sinusitis; and copper sulfate for certain fungus diseases.

HANDLING AN OUTBREAK OF DISEASE

A daily inspection of the flock is essential. At the first signs of the birds' becoming droopy, losing their appetite, or in any way appearing abnormal, one should start looking for the possible cause. Every disease outbreak should be considered infectious until the contrary is proved. From the first appearance of abnormalities in a flock, the following suggestion should be observed:

1. Isolate all abnormal birds. The best method is to remove the healthy-

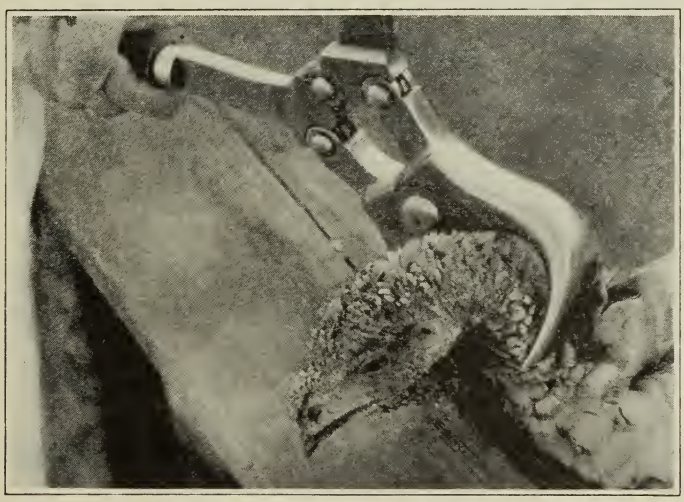

Fig. 6.—Use of Burdizzo forceps in killing a turkey. When brought into a closed position carefully, the jaws separate the vertebrae and sever the spinal cord and jugular vein without breaking the skin.

looking individuals and put them in cleaned and disinfected quarters or on ground that has not been used for turkeys for several weeks. Be sure that all the feed and water containers are thoroughly cleaned and disinfected before being transferred to the new quarters.

2. If the cause cannot be readily determined, secure the services of a veterinarian or have a diagnostic laboratory examine a few of the typical sick specimens.[11]

3. Kill hopelessly sick birds by breaking their necks to avoid shedding of blood and thus prevent the spread of infections that are present in the blood stream. A convenient tool for the purpose is a Burdizzo forceps like that used for castrating lambs (fig. 6).

[11] The State Department of Agriculture maintains free diagnostic laboratories at 9th and L streets, Sacramento; 627 F Street, Petaluma; and 1451 Mirasol Street, Los Angeles.

4. Burn or bury dead birds. If buried they should be placed deep enough to insure their not being dug up by dogs or other animals. Quicklime spread over carcasses is suggested as a further aid.

5. Thoroughly clean and disinfect all houses and equipment. If the affected birds are in yards, these should be cleaned of all refuse to allow the sun's rays to aid in disinfecting all parts. Put feeders and waterers on suitable wire platforms (fig. 3).

6. Keep fresh water before the birds at all times. The water containers should be thoroughly washed and disinfected at least once daily. Antiseptics in the drinking water are of questionable value and may cause turkeys to seek other sources of water supply much less desirable than pure untreated water. Stagnant pools or irrigation ditches should be fenced off so the birds cannot use water from them.

7. Thoroughly clean and disinfect all feed hoppers daily.

8. Thoroughly inspect the food to determine the possible presence of decayed fish or meat scraps, spoiled milk, moldy grain, poisonous weeds, or other sources of possible trouble.

9. If diarrhea is present, administer a mild laxative, such as livestock mineral oil given at the rate of 3 quarts per 100 pounds of mash or bran for a period of 3 days. If Epsom salts are used, the amount should not exceed 1 pound to each 1,000 pounds of turkeys; many turkey growers make the mistake of giving too large doses. *Milk flushes, though satisfactory for certain disease conditions, may cause severe losses in others. It is not desirable, therefore, to give milk in quantities for medicinal purposes until a definite diagnosis has been obtained.*

10. Avoid sudden changes of feed. If the feed is the cause of the trouble, a new diet is warranted; but any changes should be made by gradually increasing the new formula. Usually reduction of the protein level of the ration is desirable during an attack of enteritis, a common manifestation in most of the ordinary diseases of turkeys. The addition of bran to increase the bulk of a feed and the use of a so-called "meal method" of feeding will often aid in stopping a mild case of enteritis which might cause severe losses if untreated.

11. Avoid tonics, medicated powders, and other remedies until after obtaining a reliable diagnosis. All remedies should be given under the direction of someone skilled in therapeutics. Remedy salesmen are, as a rule, not qualified diagnosticians; and not too much faith should be put in their advice. This statement holds for many feed salesmen. Often turkey growers are led to believe that their birds are suffering from some mysterious disease when the cause is apparent to a trained person. After a diagnosis has been made, the recommendations for the specific disease should be observed.

DIETARY DISEASES[12]

Turkeys do not always respond to the nutritional factors in the same way as chickens do, and for this reason their requirements are often different. Likewise, the pathological changes seen when these factors are lacking may vary from what is seen in chickens under similar conditions. Only the pertinent facts and differences are given in this section. For more complete information on the nutritional requirements of birds, the reader is referred to recent references in the literature.

Six vitamins (A, B_1, D, E, G, and K) are definitely known to be needed by turkeys, according to Asmundson and Jukes.[13] Vitamins are especially important in the starting ration because poults have a higher requirement for some of the vitamins than do baby chicks. All vitamins required by turkeys are present in the commonly used feedstuffs; it is not necessary to buy mysterious, high-priced patent mixtures to supply them. Vitamins A, D, and G (riboflavin) are most apt to be deficient in turkey rations. Vitamin B_1 and vitamin K are both needed by turkeys, but are present in all ordinary rations to an extent which makes deficiency nearly impossible. A deficiency of pantothenic acid (filtrate factor) is the cause of dietary dermatitis in chickens, but does not cause it in turkeys. Lack of this factor will, however, slow up growth. It is present in most turkey feeds in amounts that are adequate for growth.

AVITAMINOSIS-A

Vitamin A, a fat-soluble vitamin, is found in many fish oils, in all green leaves, yellow corn, yellow carrots, and similar yellow and red root crops. Vitamin A exists in both plant and animal forms. The plant form is known as carotene, an orange-red pigment. The animal form of vitamin A is nearly colorless and is present in certain fish oils. Birds have the power of converting the plant form of vitamin A to the animal form; it does not seem to matter which form is fed to birds, because they can make equally good use of either.

Since turkeys require considerably more vitamin A than do chickens, they are more susceptible to avitaminosis-A. Hinshaw and Lloyd,[14] Scott,[15] and Wilgus[16] have shown that turkeys require from two to four times as much vitamin A in their rations as do chickens.

[12] Written in coöperation with Dr. T. H. Jukes.

[13] Asmundson, V. S., and T. H. Jukes. Turkey production in California. California Agr. Ext. Cir. 110:1–78. 1939.

[14] Hinshaw, W. R., and W. E. Lloyd. Vitamin-A deficiency in turkeys. Hilgardia 8(9):281–304. 1934.

[15] Scott, H. M. Turkey production in Kansas. Kansas Agr. Exp. Sta. Bul. 276: 1–95. 1937.

[16] Wilgus, H. S. Experiments show turkey poults need four times as much vitamin A as do chicks. Colorado Agr. Exp. Sta. Farmers' Bul. 2(1):3–4. 1940.

Symptoms.—Poults fed a vitamin-A-free diet from the time of hatching begin to show symptoms within 3 to 4 weeks, according to the amount of storage in their bodies at the start. They appear listless, walk unsteadily, and have a tendency to sit with sagging wings, drooping heads, and closed eyes. Later symptoms include watery eyes, swelling of the third eyelid (nictitating membrane), and nasal discharge. A milky exudate, followed by a white cheesy exudate, appears in the eyes and head sinuses if the poult lives for any period after showing the first symptoms. The nictitating membrane has a dry, rough appearance, and the surface may be covered with finely divided powdery exudate. When

Fig. 7.—A 5-week-old poult and a 6-week-old chick, both showing typical symptoms of vitamin-A deficiency. (From *Hilgardia*, vol. 8, no. 9.)

observed early in the morning, many poults will be found with their eyes closed by a sticky exudate adhering to the lids. Figure 7 shows, for comparison, a poult and a chick, both exhibiting typical symptoms. The course of the disease in poults is very short, and 100 per cent mortality occurs within 2 weeks after symptoms (fig. 7) appear, if vitamin A is not supplied.

In older birds receiving inadequate amounts of vitamin A, the symptoms are similar but more pronounced, probably because of the chronicity of the disease. In many instances symptoms that cannot be differentiated from colds and infectious sinusitis are observed. It is, therefore, highly desirable in all outbreaks of these diseases in turkeys to eliminate the possibility of vitamin-A deficiency when making a diagnosis.

Autopsy Findings.—Lesions are confined principally to the upper digestive tract and to the head. They consist of swollen caseated glands (pustules) in the posterior part of the mouth (figs. 8, 9), the upper esophagus, and the crop and an involvement of the sinuses of the head (fig. 28). The bursa of Fabricius (fig. 8, *C*), an accessory pouchlike organ present only in young poults and located dorsal to the rectum and having

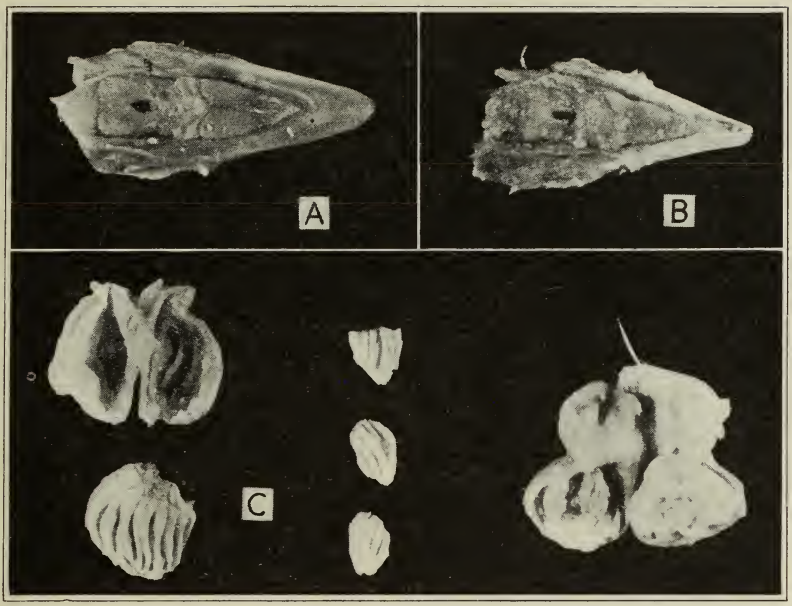

Fig. 8.—Lesions of avitaminosis-A. Effect on mouth and pharyngeal region of a 40-day-old turkey is shown in *A*, and of a 45-day-old chick in *B;* note the large number of pustules in the latter. *C*, Sagittal section of bursas of Fabricius and caseous plugs characteristic of the disease; the left bursa was from a poult, the right from a chick. (From *Hilgardia*, vol. 8, no. 9.)

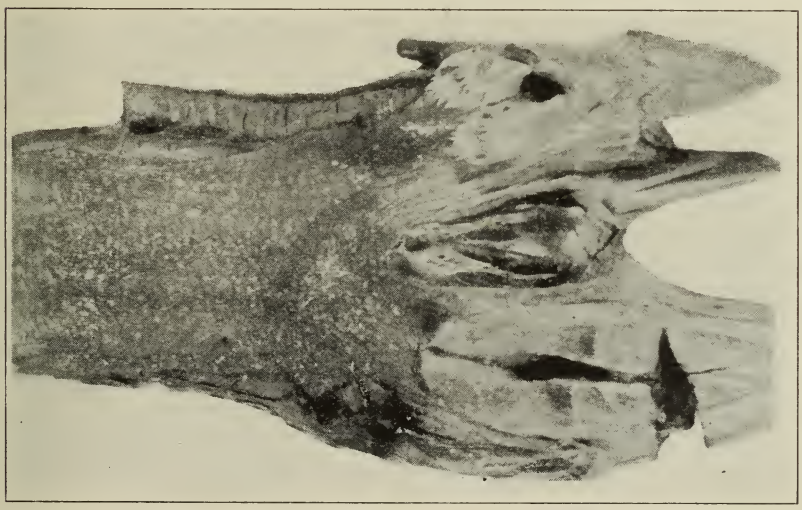

Fig. 9.—Portion of head and esophagus of a turkey hen laid open to show the pustular lesions in this part. (From *Hilgardia*, vol. 8, no. 9.)

an opening into the cloaca, is usually filled with a white, flaky exudate. Urate deposits on the intestines, heart, and lungs, and swollen kidneys filled with urates, which are common in chickens suffering from vitamin-A deficiency, have not been observed.

By means of chemical tests available in many diagnostic laboratories it is possible to determine if turkeys have adequate storage of vitamin A in their bodies. These tests are based on the determination of provitamin A or vitamin A in the livers and may at times prove an aid in differentiating avitaminosis-A from diseases showing similar symptoms.

TABLE 1

INTERNATIONAL UNITS OF VITAMIN A IN VARIOUS FEEDSTUFFS

Feedstuff	Approximate units of vitamin A per pound*	Per cent in ration to supply 4,500 units per pound
Yellow corn	3,000	50 per cent would supply only one-third enough
Alfalfa meal, containing 45 milligrams of carotene per pound	75,000	6
Fresh green leaves	45,000	10
High-potency fish oil, 3,000 A	1,360,000	0.33

* The vitamin-A unit referred to is the United States Pharmacopoeia (XI) unit, which is the same as the International unit, defined as the activity of 0.6 micrograms of beta carotene of the International Standard Reference.

Control and Prevention.—Control and prevention consist of furnishing sufficient vitamin A in the ration. This can be supplied by feeding the birds all the fresh green alfalfa or similar succulents that they will consume. These can be in the form of alfalfa, clover, kale, lettuce, or any other leafy green vegetable. Yellow carrots are an excellent source of vitamin A and, if finely chopped, are relished by turkeys. Poults should receive 4,500 units of vitamin A per pound of feed to be on the safe side. The requirements for mature turkeys are not known, but 4,500 units of vitamin A per pound of feed is probably sufficient. Table 1, taken from Asmundson and Jukes,[17] gives the approximate potency of the common sources of vitamin A in turkey rations and indicates how much of each feedstuff would be needed to supply 4,500 units of vitamin A per pound. Obviously, if more than one source is present in the ration, the amount of each source required will be less than if only one source were used.

The table shows how important is the carotene content of alfalfa meal. As turkeys become older, they are able to consume comparatively

[17] Full citation given in footnote 13.

large amounts of bulky feeds such as fresh greens and alfalfa meal. These feeds are the most practical and economical sources of vitamin A and the vitamin-G complex for older birds. It should be noted that the vitamin A content of fish oils tends to diminish after the oil has been mixed in the mash, and that when alfalfa meal is stored the vitamin A content decreases, especially in warm weather.

RICKETS

(Avitaminosis-D)

Rickets, a bone disease affecting all animals and birds, is caused by a failure to receive a proper balance of vitamin D and minerals. Vitamin D is also necessary for egg production and hatchability. A lack of it contributes to the development of crooked breast bones in turkeys. This vitamin is present in certain fish oils. It is also supplied by direct sunlight, which changes certain substances in the skin to vitamin D. Vitamin D is of great importance to poults, which have a high requirement for this factor.

Symptoms.—Leg weakness, awkwardness of gait, softness of the beak and leg bones, and ruffled, unkempt feathers are characteristic symptoms of this disease. The affected poults fail to gain weight and finally die if the balance of minerals and vitamin D is not corrected. According to Scott, Hughes, and Loy,[18] poults receiving a diet deficient only in vitamin D will develop symptoms in 18 to 20 days, and 100 per cent mortality will occur within 30 days after hatching.

Autopsy Findings.—Softness of the bony structures and beading of the ribs are the most common autopsy findings. A definite diagnosis depends on a chemical analysis of the bones or blood or upon the "line" test for rickets.

Prevention and Control.—There are several forms of vitamin D, some of which are very effective for the prevention of rickets in rats, but not in chicks and poults. For this reason a source of Vitamin D, such as fish oil, should be tested with chicks before it is used in turkey feeding.

Poults need several times as much vitamin D in their feed as chicks. This explains why poults sometimes develop rickets when placed on chick starting mashes. According to Jukes and Sanford,[19] a poult starting mash should contain 200 A.O.A.C. chick units[20] of vitamin D per 100

[18]. Scott, H. M., J. S. Hughes, and H. W. Loy. Rickets in young turkeys. Poultry Sci. 11:177–80. 1932.

[19] Jukes, T. H., and T. D. Sanford. The vitamin D requirement of turkeys. Jour. Nutrition 18(1):71–85. 1939.

[20] The vitamin-D chick unit referred to in this publication is that determined according to the tentative procedure of the Association of Official Agricultural Chemists in which it is defined that 1 U.S.P. unit of vitamin D equals 1 A.O.A.C. chick units.

grams of feed for complete protection against rickets, in the total absence of direct sunlight. This may be supplied by 0.5 per cent of a 400-D fish-oil concentrate (containing 400 A.O.A.C. chick units of vitamin D per gram) or by an equivalent percentage of a vitamin-D oil of some other strength. If the poults are receiving some direct sunlight, 0.3 per cent of 400-D oil may be sufficient in the starting mash.

Biologically tested fish oils of guaranteed vitamin-D potency are the only oils that are suitable for supplying turkeys with vitamin D. Fish oils that have no guarantee of potency may or may not contain vitamin D.

It is a good practice to add a chick-tested fish oil to the ration of the breeding flock to insure an adequate storage in the egg for development of the embryo and for starting the poult after it is hatched. Since sunshine cannot be depended upon during the brooding season, fish oil should be a regular part of the ration until the poults are put out on the range. Whether or not fish oil should then be continued depends on the amount of sunshine available. A proper balance of minerals, especially calcium and phosphorus, is also essential in preventing rickets.

DIETARY DERMATITIS

(Vitamin G, or riboflavin, deficiency)

Vitamin G is now known to consist of several factors. Jukes[21] has shown that at least two of these factors are needed by turkeys. The first is riboflavin and the second is pantothenic acid (filtrate factor). Poults fed a ration deficient in riboflavin develop symptoms of dermatitis.

This deficiency disease may be seen in the field, but other forms of dermatitis are also common and must be considered in making a diagnosis. Little is known about the other types of this deficiency disease.

Symptoms.—The symptoms of dietary dermatitis in poults consist of a sore mouth and encrustations at the corners of the mouth; diarrhea, resulting in an inflamed encrusted vent; thickened eyelids that tend to stick together; ragged feathers; and a listless, unthrifty appearance. In advanced cases the feet may also be involved (fig. 10). Growth is very slow, and mortality is high.

Pantothenic acid (filtrate factor) is sometimes spoken of as the "chick antidermatitis vitamin." It appears not to prevent dermatitis in poults, but if they are placed on a diet deficient in this vitamin they grow slowly and many of them die in a short time. This substance is found in moderate amounts in most poultry feeds.

Prevention and Control.—Riboflavin is very important for the promotion of growth and the production of hatchable eggs. Fresh greens

[21] Jukes, T. H. The vitamin G requirements of young poults. Poultry Sci. 17:227–34. 1938.

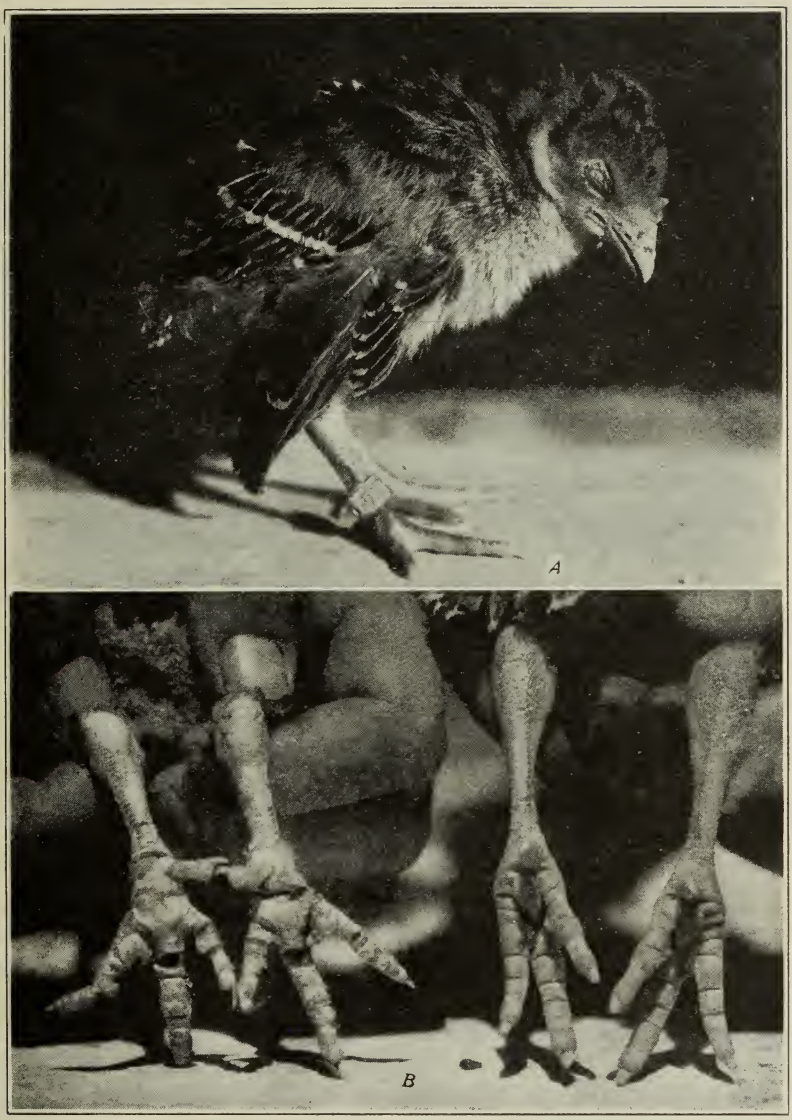

Fig. 10.—A 29-day-old turkey after 17 days on a riboflavin-deficient diet is shown in *A*. Note the encrusted eyelids, mouth, and nostrils. The feet were not showing lesions at the time this picture was taken. *B*, Legs and feet of two 3-week-old turkeys. The ones on the left are from a poult fed a riboflavin-deficient ration from hatching time. The other ones are from a poult fed the same basal ration, with riboflavin added. Note the dryness of the skin of the legs and the marked ulceration of the foot pads in the diseased specimen. In these cases the skin of the legs and feet peels at the slightest touch. (Courtesy of T. H. Jukes.)

and alfalfa meal are the cheapest source of riboflavin, which is also present in milk or whey.

Poults should be given approximately the same amount of riboflavin in their ration as chicks. Poult starting mashes should contain alfalfa meal and, in addition, dried milk or dried whey as sources of riboflavin. Older turkeys, however, may receive their complete riboflavin requirement from fresh greens and alfalfa meal. Consequently, riboflavin is readily supplied in the ration of older turkeys, which should receive 10 per cent or more of alfalfa meal in their mash. It is a good plan to supply them with fresh greens and alfalfa hay, if these are available.

Fig. 11.—A turkey poult with slipped tendon, caused by too high a level of bone meal in the ration. The hock joint was dislocated, but the poult was otherwise healthy. (From Ext. Cir. 110.)

PEROSIS

(Slipped tendon, hock disease, spraddle legs)

Perosis (figs. 11, 12) may cause considerable loss to turkey growers if not prevented by use of a properly balanced ration. Jukes[22] has shown that this condition in turkeys is associated with an improper balance of calcium, phosphorus, manganese, and choline in the ration.

This disease should not be confused with a similar condition of newly hatched poults which is also called spraddle legs. This latter condition is caused by one of a number of factors, including faulty incubation, improper diet in breeding stock, and faulty structure of hatching trays.

Symptoms.—The symptoms seen in perosis are bowed or badly twisted legs caused by improper calcification of the tibia and metatarsus, especially at the hock joints. This deformity allows the tendon of

[22] Jukes, T. H. Effects of choline and other supplements on perosis. Jour. Nutrition 20(5):445–58. 1940.

Achilles to slip from its groove. In turkeys the metatarsus often turns at a right angle, giving the name "spraddle legs" to the condition. Occasionally, the femorotibial joint is affected. There is usually an enlargement and flattening of the hock joint and sometimes of the entire shank.

Prevention.—There is no cure for the disease after it reaches the deformity stage. According to Asmundson and Jukes (cited in footnote 13, page 25), a poult ration containing from 0.8 to 1.0 per cent phosphorus and 1.8 to 2.0 per cent calcium may be relied upon to provide enough calcium and phosphorus for bone formation and at the same time prevent perosis under ordinary conditions. Jukes found that choline is a necessary adjunct along with manganese to supplement the ration, and recommends 0.2 per cent choline and ½ pound of manganese to a ton of mash as preventives. Jukes found that soybean meal, pork liver, sardine meal, and barley are sources of choline. Soybean meal was fully protective at a 25 per cent level of the ration. Partial protection was obtained with either 17 per cent sardine meal, or 5 per cent of dried pork liver, or 65 per cent barley.

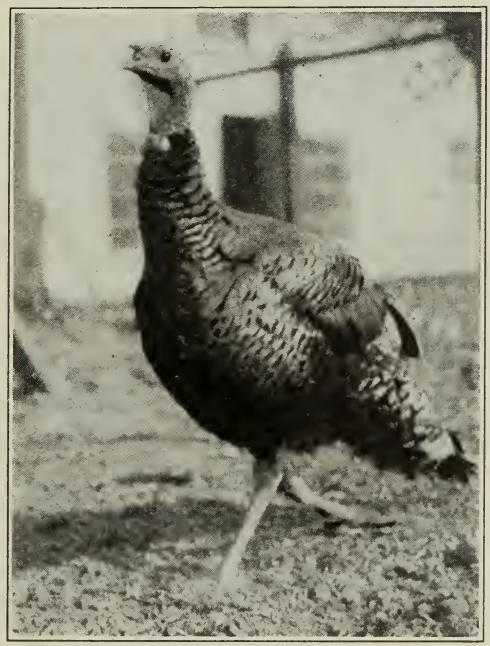

Fig. 12.—An advanced case of slipped tendon in a mature turkey. Note the rotation of the right leg at the hock joint.

Hopper-feeding of limestone grit to growing turkeys is not recommended; this is an unnecessary and a dangerous practice, since it throws the minerals in the ration out of balance. If grit is to be supplied, it should be an insoluble type, such as granite.

FUNGUS DISEASES

Fungus diseases, caused by molds and yeasts, occasion considerable mortality in turkeys in this state. The most important are aspergillosis, favus, and moniliasis.

ASPERGILLOSIS

(Brooder pneumonia, mycotic pneumonia, pneumo-mycosis)

Aspergillosis, more commonly known in the field as brooder pneumonia, is caused principally by *Aspergillus fumigatus*, although some other molds of the same genus may at times be responsible. *A. fumigatus* is widely distributed in nature and is pathogenic for many animals, including man. In young poults kept on contaminated litter, it produces a pneumonia with heavy mortality. Infected older birds may suffer from pneumonia or air-sac infection. Baker, Courtenay-Dunn, and Wright[23] are of the opinion that molds belonging to other genera may also be responsible for mycotic pneumonia in birds. Durant and Tucker[24] reported an outbreak in wild turkey poults reared in captivity. The disease appeared at 5 days of age and reached a maximum mortality rate at 15 days. When the epizootic subsided at the end of 3 weeks, only 200 of the 785 poults remained alive.

Symptoms.—The symptoms depend on the seat of infection. Lesions in the mouth, trachea, or bronchi produce hoarseness, heavy breathing, and sometimes rattling in the throat. Birds suffering from air-sac infection alone may not show any symptoms. As the disease progresses, dullness, labored breathing, and emaciation may be seen. Death probably results from either toxemia or asphyxiation. The mortality varies, but is usually greater in brooder poults than in older birds.

Autopsy Findings.—Diagnosis is readily made in advanced cases. The lungs and air sacs are the principal seats of infection, but the disease may extend into the peritoneal cavity or into the air passages of the bones (fig. 13). The kidneys, liver, and spleen may be affected by direct contact from the air sacs. Yellow, semiliquid, or caseated masses in the air sacs and lungs, with buttonlike ulcers attached to the mucous membranes, are common. In the early stages these ulcers appear as round, yellowish-white masses attached to the membrane. In advanced cases

[23] Baker, A. Z., J. Courtenay-Dunn, and M. O. Wright. Observations on fungal pneumonia in domestic fowl. Vet. Jour. (London) 90:385–89. 1934.

[24] Durant, A. J., and C. M. Tucker. Aspergillosis of wild turkeys raised in captivity. Amer. Vet. Med. Assoc. Jour. 86:781–84. 1935.

a greenish mold turf may be seen over the surfaces of the infected areas and in the convex depressions of the ulcers, especially in the air sacs. Final diagnosis depends on identification of the mold. The fungus can be readily demonstrated by microscopic examination of specimens that have been treated with 10 per cent sodium or potassium hydroxide and by culturing on suitable media. A careful examination of the surface of the buttonlike lesions will often reveal aerial hyphae, and seedings from these will usually insure a pure culture (fig. 14).

Fig. 13.—Lungs of turkey showing typical caseous nodules seen in the early stages of aspergillosis. Note also irregular lesion with center darkened by aerial hyphae of the fungus, denoted by the arrow.

Prevention, Control, and Treatment.—Careful selection of grain and litter is essential in preventing this disease. Access to musty, moldy strawstacks should be avoided. Dehydrated beet pulp and sugar-cane litters may be fertile media for growth of molds because of the possible residue of sugar left in them. Special care should be taken to keep such litters dry while in storage or in use. A common source of the infection is semisolid milk from barrels that have been improperly cared for. If used, semisolid milk should always be kept covered with water to prevent mold growth over its surface.

Improperly kept drinking fountains used for dispensing milk have also been found to be a source of infection. One outbreak observed by the writer was associated with contaminated milk cans. The undersides

of the lids of the cans used for transporting milk were found to be covered with a fine mold growth; the owner had washed and scalded the cans daily, but thought it unnecessary to clean the lids. The storage barrels for the milk were also heavily infected.

The areas around feed hoppers and watering places are fertile fields for the growth of molds. Unless a permanent yard system is used, frequent moving of feed troughs and watering places is advisable. Placing feed containers and watering fountains on screened elevated platforms

Fig. 14.—Microscopic appearance of aerial hyphae of *Aspergillus* from a specimen like that seen in figure 13. (x 920.)

helps to prevent turkeys from picking up molds that develop in such places. Drainage is advisable with areas where water may stand after rains.

Control is best accomplished by removing the cause. A careful search should be made for mold in the litter, the feed, and the feed and water containers. Daily cleaning and disinfection of feed and water utensils with a 0.5 per cent copper sulfate solution will aid in eliminating the infection. Spraying of the ground around the containers with chemical solutions may be advisable if it is impossible to change feeding areas frequently. In outbreaks, a 1–2,000 solution of copper sulfate in place of all drinking water may be used to aid in preventing the spread through this means, though it should not be relied upon as a preventive to be used continually. See page 19 for method of preparing 1–2,000 solution of copper sulfate. If liquid or semisolid milk is fed, copper sulfate may be added to it in the same proportion.

The deep-seated nature of the disease renders treatment of little avail. Extreme care should be used in handling and disposing of sick birds, because of the possible danger of transmitting the disease to the attendant.

FAVUS

Favus is a chronic skin disease caused by a fungus, *Achorion gallinae*, and characterized by whitish areas about the exposed skin parts of the body. It is not common in California. Since man is susceptible, care should be taken to prevent transmission if an outbreak occurs.

The disease is generally mild and sporadic in nature. It may last in a flock for several months, but few losses directly traceable to it are experienced.

Symptoms.—The white powdery spots which characterize the disease usually appear first around the beak. Thence they spread to the wattles,

Fig. 15.—A generalized case of favus. (Courtesy of L. D. Bushnell, Kansas State College.)

dewlap, and caruncles, and in extreme cases to the feathered portions. The fine pin-point white spots finally coalesce and may cover a considerable area. As the fungus spreads and grows, a piling up of the threads occurs, and a thick, crustlike area may result (fig. 15).

Prevention, Control, and Treatment.—Removal and disposal of all infected birds is recommended. It is well to move the flock to new quarters when practicable. After removal of infected individuals, the premises must be thoroughly cleaned and disinfected.

Treatment should be attempted only in very valuable birds. A mixture of 6 parts of glycerine and 1 part of iodine applied locally is recommended by Van Heelsbergen[25] for the infected parts. Beach and Halpin[26]

[25] Van Heelsbergen, T. Handbuch der Geflügel-krankheiten und der Geflügelzeicht. Verlag Von F. Enke, Stuttgart. 608 p. 1929.

[26] Beach, B. A., and J. G. Halpin. Observations on an outbreak of favus. Jour. Agr. Res. 15:415–18. 1918.

have recommended a formalin vaseline as an effective treatment. This ointment is prepared by shaking in a closed jar 5 per cent by weight of formalin in melted vaseline. The ointment thus prepared should be thoroughly rubbed into the affected parts.

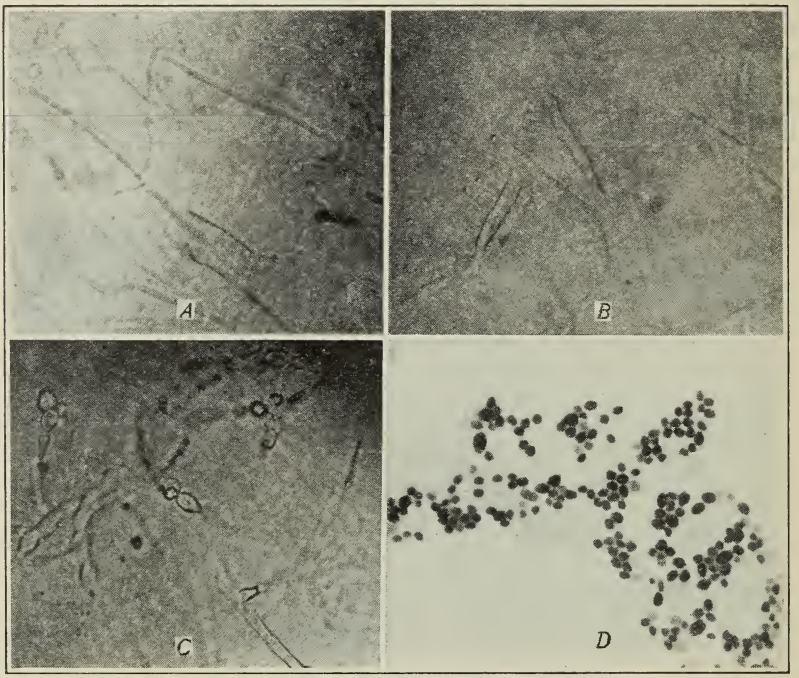

Fig. 16.—*A*, *B*, Microscopic appearance of scrapings from the crop of a turkey affected with moniliasis. *C*, Microscopic appearance of liver-tissue smears from a rabbit infected with a culture of *Monilia* isolated from a turkey. *D*, A 48-hour culture isolated from the crop of a turkey; stained by Gram's method. (x 650.)

MONILIASIS

(Mycosis of the crop, thrush)

Moniliasis is a disease of the upper digestive tract of both chickens and turkeys, caused by yeastlike organisms belonging to the genus *Monilia* (fig. 16). Jungherr[27] was probably the first in the United States to observe the disease in chicks; Gierke[28] has reported an outbreak of a thrushlike disease occurring in turkeys in California during the summer of 1931; and the writer[29] has described the results of studies on several

[27] Jungherr, E. L. Observations on a severe outbreak of mycosis in chicks. Jour. Agr. Res. 46:169–78. 1933.

[28] Gierke, A. G. A preliminary report on a mycosis of turkeys. California Dept. Agr. Monthly Bul. 21:229–31. 1932.

[29] Hinshaw, W. R. Moniliasis (thrush) in turkeys and chickens. World's Poultry Congress 5th Proc. Paper 97:1–8. 1933.

outbreaks in turkeys and chickens. Wickerham and Rettger[30] in a taxonomic study of *Monilia* species from various sources included several strains isolated by the present writer from turkeys and chickens. These proved to be *M. albicans* and indistinguishable from species isolated from humans. Jungherr[31] found in his later studies that *M. albicans* and *M. krusei* and *Odium pullorum* n. sp. were the most frequently isolated yeastlike fungi, from chicks. Of these, he considered *M. albicans* and *O. pullorum* of etiological importance. He was able to transmit the disease in chicks by feeding fecal material from diseased chicks and by injecting pure cultures of *M. albicans*. The average period of incubation under experimental conditions was 31 days. He also succeeded in isolating *Monilia* from the cloaca of laying hens affected with a moist type of vent gleet. He presented evidence that the causative organisms may live on the shell of the egg and carry the infection to young chicks in the incubator. He has not, however, definitely proved transmission by this means.

The present writer was able to transmit the disease from turkeys to turkeys, chickens, and rabbits. The disease is associated with poor management, where unsanitary surroundings prevail and debilitation is prevalent. It must be differentiated from the disease formerly described by Jungherr[32] as a mycosis of the crop of turkeys but now known to be caused by a *Trichomonas*. (See the section "Trichomoniasis of the Upper Digestive Tract.")

Symptoms.—As most of the outbreaks observed have been complicated with some other pathologic condition, specific symptoms have been difficult to determine. More or less constant symptoms have, however, been listlessness, loss of appetite, tendency to stand around with heads drawn back on the shoulders, and a sunken appearance of the chest. The eyes and sinuses appear sunken, and the heads haggard.

Autopsy Findings.—The crop has been the most common seat of infection. Fungi have also been demonstrated in scrapings from the mouth, infraorbital sinuses, upper and lower esophagus, proventriculus, gizzard, and intestines. Cultures of the causative organism have readily been obtained from all of these organs and in addition from a lung abscess and from a skin abscess.

In the more acute cases, as well as in the milder cases, there is seen a catarrhal to thick mucoid exudate with a tendency to form a pseudo-

[30] Wickerham, L. J., and L. F. Rettger. A taxonomic study of *Monilia albicans* with special reference to morphology and morphological variation. Jour. Trop. Med. and Hygiene. 42:174–77, 187–92, 204–16. 1939.

[31] Jungherr, E. Studies on yeast-like fungi from gallinaceous birds. Connecticut (Storrs) Agr. Exp. Sta. Bul. 188:1–19. 1933.

[32] Jungherr, E. Two interesting turkey diseases. Amer. Vet. Med. Assoc. Jour. 71:636–40. 1927.

membrane. Soft, raised, whitish-yellow ulcers having a roselike appearance and scattered over the surface, at times coalescing to form a solid mass of piled-up exudate (fig. 17), characterize the more chronic cases. These lesions have been variously described by turkey growers and others as having a "turkish-towel-like" or "curdy" appearance. In early or mild cases the mucous membrane may appear parboiled. The lesions

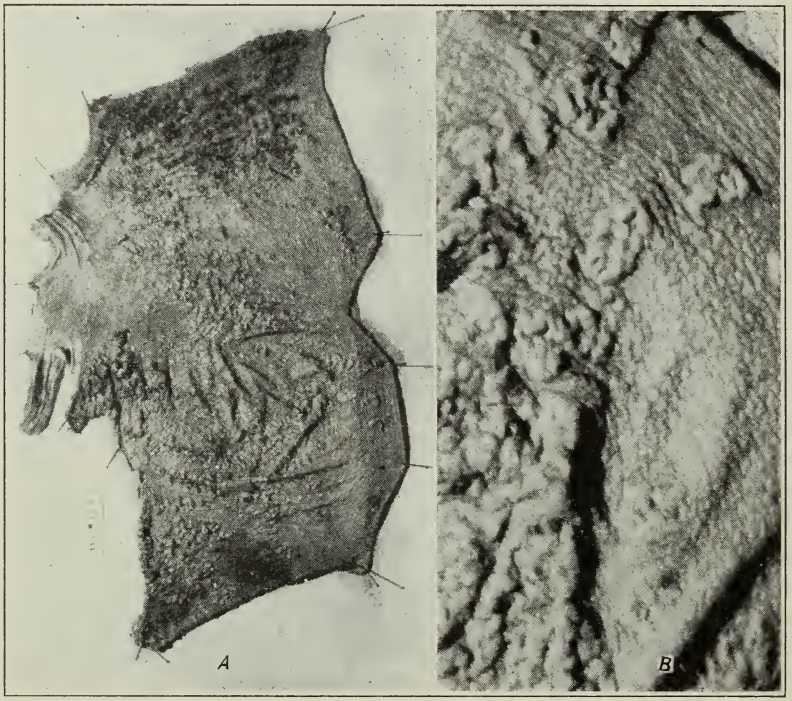

Fig. 17.—*A*, Crop of a turkey suffering from moniliasis; *B*, enlarged section of *A*; note the raised, piled-up exudate which tends to form roselike masses.

are easily scraped from the surface, leaving the mucous membrane abraded and injured to a greater or less extent, according to the severity of the infection.

In most cases the crops either have been empty or have contained a small amount of thick slimy exudate. Cultures of the fungus have been readily obtained in nearly pure state by washing off the surface exudate and planting a fairly deep scraping on 2 per cent dextrose agar, glycerine dextrose agar, or Sabouraud's honey agar of a pH of 6.0 to 6.4. The colonies are large enough and so characteristic that unless molds interfere, no difficulty is experienced in fishing individual colonies for purification.

Prevention, Control, and Treatment.—Because of the nature of the disease and its frequent association with other diseases common in crowded quarters and in flocks suffering from some form of malnutrition, sanitation and proper diet are important factors in control. Removal of birds to clean and thoroughly disinfected quarters, together with the daily cleaning and disinfection of feed and water containers, has helped to reduce losses.

Copper sulfate solution of a 1–2,000 dilution substituted for all drinking water for a few days is a helpful control procedure. It should be remembered, however, that turkeys do not like this solution; if any other source of water is available, they will not touch it. Use of crockery or wooden fountains is recommended when copper sulfate solutions are used. A convenient method of making up approximately a 1–2,000 dilution of copper sulfate solution is given under "Disinfectants" on page 19. Substitute this solution for all drinking water. Keep the solution of copper sulfate before the birds continually for at least a week after losses have ceased and flock improvement has been noted.

BACTERIAL AND VIRUS DISEASES

In this section will be included the common diseases of turkeys which are caused by bacterial agents. No attempt will be made to describe the various bacteria. In each case the causative organism is given if known, and the reader is referred to standard text books on bacteriology if descriptions are desired. The single important virus disease, fowl pox, is also included in this section.

BOTULISM

Botulism is caused by a toxin produced by an anaerobe, *Clostridium botulinum*. Of the three types of toxins poisonous to man and animals, only A and C are known to affect fowls. The toxins are produced by the microörganism while growing in such substances as decomposing food, dead carcasses, and wet grain, and are transmitted to birds when the contaminated products are eaten. Although the disease is not prevalent in California, losses are heavy when it does occur.

Coburn and Quortrup[33] have described an outbreak of botulism in turkeys caused by the type-C species. The outbreak occurred in a flock of 1,400 turkeys, ranging on a 20-acre stubble field. About 50 turkeys were sick at the time of the investigation, and 50 others had died the previous week. The source of the toxin was found to be a shallow stagnant pool of water in the stubble field, and filtered water samples from

[33] Coburn, D. R., and E. R. Quortrup. Atypical botulism in turkeys. Amer. Vet. Med. Assoc. Jour. 93:385–87. 1938.

it were proved to contain the type-C toxin by tests on white mice. *Clostridium botulinum* (type C) was also isolated from the soil taken from the water hole.

Symptoms.—The most common symptom is a complete paralysis, which gives the disease its name, "limberneck." The birds sit around with their heads and necks on the ground or extended over the back (fig. 18), often in a comatose condition. In turkeys the feathers do not shed so readily as in chickens affected with the disease. The turkeys in the outbreaks described by Coburn and Quortrup showed cyanosis of

Fig. 18.—Typical posture in botulism of turkeys.

the head, posterior paralysis, and dyspnea; but only a few had paralysis of the nictitating membrane, a symptom usually considered pathognomonic. Some of the sick turkeys recovered spontaneously.

Autopsy Findings.—Coburn and Quortrup described the following post-mortem findings: Petechial hemorrhages on the auricular pericardium, hyperemia of the duodenal mucosa, and cloaca distended with urates. Thus, the gross pathology would make one suspicious of fowl cholera. One should look for evidence of spoiled food in the crop and for the presence of fly maggots, which are suggestive of the consumption of spoiled food. Diagnosis depends on the history obtained, the symptoms and autopsy findings, but finally on the demonstration of the toxin or causative organism.

Prevention, Control, and Treatment.—Every effort should be made to prevent turkeys from obtaining foods that might harbor the botulism organism. Spoiled canned vegetables should never be given, for they are liable to contain botulinus toxin.

When the disease appears, all the birds should be moved to a new feeding ground and, if necessary, fenced in to prevent access to spoiled food. Sick birds should have plenty of shade. Their crops can be drained and flushed out with warm water with the aid of a rubber tube and a funnel or by the method shown in figure 55. Large doses of mineral oil or castor oil may help to get rid of the toxin in birds that have not gone into a coma. The cause of the trouble should be traced, and recurrence prevented. In valuable birds polyvalent (mixed) botulinus antitoxin may be used. Information regarding this product can be obtained from veterinarians.

Persons handling turkeys suffering from botulism should keep in mind that botulinus toxin may affect man. Careful washing of the hands after care of the birds is suggested as a precautionary measure.

ERYSIPELAS

This disease, caused by the swine erysipelas organism *Erysipelothrix rhusiopathiae,* was first reported in turkeys by Jarosch[34] in 1905. The first outbreak to be reported in the United States was made by Beaudette and Hudson.[35] This outbreak occurred in 1936 in New Jersey. A complete bibliography of the literature to that date is included in their paper. Since 1936 the disease has been reported in the United States from Utah by Madsen;[36] from New York, Vermont, and Massachusetts by Van Roekel, Bullis, and Clarke;[37] from California by Hoffman and Hinshaw;[38] and from Oregon by Rosenwald and Dickinson.[39] In a later report, Dickinson and Rosenwald[40] gave the results of studies on 16 outbreaks involving 30,000 immature turkeys. They state that the epizootiology of the disease in turkeys is highly variable and erratic.

Most of the outbreaks reported by American investigators have been confined to a single flock, and no recurrence of the disease has been reported from the same ranch. Sheep, rather than swine, have been the most possible factors in transmission of the disease to turkeys in the United States.

[34] Jarosch, W. Über die Septikämie der Truthühner. Oesterreichische Monatssch. für Tier. 29:197–99. 1905.

[35] Beaudette, F. R., and C. B. Hudson. An outbreak of acute swine erysipelas in turkeys. Amer. Vet. Med. Assoc. Jour. 88:475–87. 1936.

[36] Madsen, D. E. An erysipelas outbreak in turkeys. Amer. Vet. Med. Assoc. Jour. 91:206–08. 1937.

[37] Van Roekel, H., K. L. Bullis, and M. K. Clarke. Erysipelas outbreaks in turkey flocks. Amer. Vet. Med. Assoc. Jour. 92:403–18. 1938.

[38] Hoffman, H. A., and W. R. Hinshaw. Erysipelas in turkeys. Poultry Sci. 17:443. 1938.

[39] Rosenwald, A. S., and E. M. Dickinson. A report on erysipelas in turkeys. Cornell Vet. 29:61–67. 1939.

[40] Dickinson, E. M., and A. S. Rosenwald. Swine erysipelas in turkeys. Amer. Jour. Vet. Res. 2:202–13. 1941.

The outbreaks have usually occurred in turkeys approaching the market age, and males have appeared to suffer the heaviest losses. Dickinson and Rosenwald have, however, diagnosed the disease in poults from a few weeks of age to maturity.

Symptoms and Mortality.—The disease manifestations as described by Beaudette and Hudson are primarily those of a septicemia. The mortality in the outbreak studied by them was high, 200 of a flock of 500 dying in 9 days This is a heavier mortality than reported by most investigators.

The symptoms are listlessness, drooping tails and wings, and little or no diarrhea. Swelling of the joints of the legs has been noted, but this is not a constant symptom. Madsen reported that the affected birds remained aloof from the remainder of the flock. This has also been noted by the present writer. These sick birds have a tendency to crouch, the heads often appear cyanotic, and a nasal catarrh is a common symptom. Effect on the appetite seems to vary in different outbreaks, though most investigators agree that feed consumption is lowered. Both acute and subacute forms are seen in turkeys. Recovery in some acute cases, according to Van Roekel, Bullis, and Clarke, may be complete in a week or 10 days.

The effect of the disease on body temperature of birds is not reported in the available literature. According to Van Es and McGrath,[41] infected swine may show temperatures as high as 110° F in acute outbreaks. The present writer has observed temperatures in field cases of sick turkeys as high as 109.6°; but rise in temperature has not been consistent.

Adult turkey hens artificially infected with *Erysipelothrix rhusiopathiae* have not shown marked increase in temperature. One such bird (19 weeks of age) given 0.8 cubic centimeter of a 24-hour broth culture became ill in 48 hours, and showed a continued rise in temperature till it reached 110.6° F on the fourth day after inoculation. On the day of its death (the sixth after inoculation) the temperature was 109.8°. Another, which became visibly ill in 48 hours but recovered within 2 weeks, showed a very slight rise in temperature during the period of visible symptoms. A third turkey hen showed an increase from 104.9° on the day before inoculation, to 108.8° on the sixth day after inoculation. Its temperature gradually subsided, though the bird itself developed a chronic type of the disease and was finally killed in an emaciated condition, in 4 weeks. The above data, as well as other unpublished data in the writer's files, indicate that turkeys sick with the disease do show a rise in temperature but that this rise is not consistent.

[41] Van Es, L., and C. B. McGrath. Swine erysipelas. Nebraska Agr. Exp. Sta. Res. Bul. 84:1–47. 1936.

Autopsy Findings.—Diffuse hemorrhage areas of various sizes are common in the breast muscles. The skin of the breast may appear pink, but no diamond-shaped lesions (seen in swine) have been described. The nasal passages are usually filled with a thick mucus; the livers are enlarged, congested, and friable. Catarrhal enteritis is evident, with some reddening of the mucosa of the large intestine. In most cases the spleens are enlarged, mottled, and friable, hemorrhages sometimes occurring. Other lesions occasionally found are hemorrhages in the pericardium, congestion of the kidneys and lungs, and, rarely, browning of the lung tissue.

Diagnosis.—The marked hemorrhagic condition of the fascial and muscular tissues of the breast is the most significant finding at autopsy, according to most investigators. Diagnosis must be confirmed by isolation of the causative organism. Differentiation from fowl cholera is necessary because of the similarity of the two diseases. The use of mice and pigeons for inoculation tests is recommended, as is the use of swine erysipelas antiserum for neutralization tests in the inoculated test animals. Mice or pigeons given either pure cultures of the organism, or tissues from diseased cases, die within 24 to 96 hours. Similarly infected animals protected with 0.5 cubic centimeter of antiserum do not get sick.

Another aid to diagnosis is to stain blood or liver smears by Gram's method. The characteristic Gram-positive rods (which decolorize easily, however) are usually grouped on interlacing bundles. The individual organisms are slender, slightly curved, and show characteristic granules. It is possible to isolate the causative organism from the bone marrow of turkeys which have been dead as long as 2 weeks. The writer has even isolated it from the marrow of the small metatarsals cut from carcasses that have lain on the range for at least 2 weeks.

Prevention, Control, and Treatment.—Since the disease is common in swine and sheep in the United States, turkeys should be kept away from these animals, at least in areas where erysipelas is known to exist. Moving the infected flock to new range, with segregation of the sick birds, is recommended. Taking temperatures of the birds may be an aid to determine the sick birds, but cannot be depended upon to pick all of the birds in the early stages. The use of swine erysipelas antiserum in sick flocks has been suggested, but inconsistent results have been reported. Van Roekel, Bullis, and Clarke (cited in footnote 37, p. 43) reported favorable results in one outbreak where 91 exposed turkeys were given 10 cubic centimeters of swine erysipelas antiserum to each bird by the intraperitoneal route. In contrast, Dickinson and Rosenwald (cited in footnote 40, p. 43) say that satisfactory results were not obtained by its use under controlled field and laboratory conditions.

FOWL CHOLERA

Fowl cholera, caused by *Pasteurella avicida,* results in severe economic losses to turkey growers in certain areas, but the incidence of outbreaks is small as compared with some other diseases. DeVolt and Davis[42] reported an outbreak in a flock of 175 turkeys in Maryland where there was a 17 per cent mortality. In the present writer's experience, the disease has been most prevalent in turkeys of about marketable age (6–8 months). In many outbreaks, chickens have been shown to be the source of the disease; but recent observations indicate that it may also be carried by adult turkeys. The organisms isolated from turkeys have been identical with those isolated from chickens.

Symptoms, Course, and Mortality.—In many respects the symptoms resemble those seen in fowl-typhoid outbreaks. They include thirst, loss of appetite, listlessness, a yellow watery diarrhea, and a rise of 2° to 3° F above the normal temperature. The heads appear blue to purplish and have a haggard, drawn appearance. A slimy to gelatinous exudate in the mouth and nostrils is not uncommon. The breast muscles become congested, and the skin appears pinkish.

The course of the disease is acute, and heavy losses occur within a few days, followed by intermittent losses. Symptoms may not be observed before death; in less acute cases the birds may linger several days. Very few sick turkeys recover; reports of losses of from a few birds to over half of the flock are common.

Autopsy Findings.—The autopsy findings in turkeys are typical of those in chickens, though generally more pronounced. The breast muscles are congested, and the crop usually contains considerable food having a very sour odor. The heart is often enlarged, and the pericardium may be thickened and covered with a whitish-yellow exudate. Many pin-point hemorrhages (petechiae) are commonly found over the surface of the pericardial sac, the muscles of the heart, and the adjacent tissues. The pericardial sac may be filled with a yellowish fluid containing whitish-yellow flakes. The liver is never more than slightly enlarged. It is friable and somewhat pale and may contain many minute whitish abscesses that give it a mottled appearance. The spleen may be slightly enlarged or may show no alteration.

The blood vessels of the mesentery and intestines are usually engorged with blood. The intestines lack tone and often show considerable evidence of hemorrhage, especially in the duodenum. The contents range from a semiliquid to a mucoid consistency. The feces are usually yellow to yellow-green. The gizzard seldom contains much food, but the few

[42] DeVolt, H. M., and C. R. Davis. A cholera-like disease in turkeys. Cornell Vet. 22:78–90. 1932.

contents present have a peculiar sour odor. In most cases the mucous membrane peels readily, and the muscle of the gizzard appears more red than normally.

Pneumonia is a common finding in turkeys suffering from fowl cholera. Various stages of lung involvement from congestion to complete hepatization are seen. In such cases, the pleural cavity may contain a surplus or fluid, or the air sacs may be filled with a semisolid yellow caseous mass. Similar caseous deposits may be found throughout the abdominal cavity, and such lesions have to be differentiated from aspergillosis. In the latter, the characteristic nodules and button ulcers serve as differentiating lesions.

There is a characteristic odor to the body cavities and digestive-tract contents of birds suffering from fowl cholera. This odor, difficult to describe, is that of advanced putrefaction and is recognized after experience with a few cases. Isolation of the causative organism is the final means of diagnosis.

Prevention, Control, and Treatment.—Sanitation and hygiene play an important role in prevention. Turkeys should be kept segregated from all other fowl that have suffered from the disease. Adult carriers are responsible for yearly recurrence of the disease on some ranches, and depopulation for a season may be necessary. There is no evidence that the disease is transmitted through the egg, but it is not a good plan to keep for breeding purposes turkeys that have recently suffered from the disease. Complete segregation of the breeding and brooding units or sale of the entire adult flock before any poults are hatched is a recommended preventive measure on ranches where the disease has existed.

Skidmore's[43] observations on the common housefly as a possible carrier emphasize the need for keeping turkeys well isolated from chickens or other fowls that might be suffering from the disease and for prompt destruction of all diseased birds. Burning instead of burial of dead birds is recommended; otherwise the diseased carcasses, a source of infection, may be dug up by dogs and other animals. There is no known treatment. The general recommendations given in the section "Handling an Outbreak of Disease" (p. 23), are suggested as other precautions.

FOWL POX

Fowl pox, a disease of the unfeathered parts of the birds' bodies, is characterized by the formation of pustules and scablike processes. It is caused by a filterable virus, pathogenic for chickens as well. Brunett[44]

[43] Skidmore, L. V. The transmission of fowl cholera to turkeys by the common housefly (*Musca domestica* Linn.) with brief notes on the viability of fowl cholera micro-organisms. Cornell Vet. 22:281–85. 1932.

[44] Brunett, E. L. Some observations on pox virus obtained from a turkey. New York State Vet. College Ann. Rept. 1932–33:69–70. 1933.

tested out fowl-pox viruses of chicken, turkey, and pigeon origins and reported that the turkey strain was pathogenic for chickens but not for pigeons. All three strains produced lesions in turkeys, but only the chicken and turkey strains produced immunity.

Tietz[45] reported that turkeys were not susceptible to the strain of pigeon-pox viruses used by him. The writer's experience has been more like that of Tietz, though very slight swellings of the feather follicles have been noted. Immunity tests using virus of turkey and chicken origin have agreed with the observation of Brunett.

There is considerable evidence that there is a distinct strain of turkey-pox virus which differs from both the chicken and pigeon types. Coronel,[46] Brandly and Dunlap,[47] and Beaudette and Hudson[48] have all published such evidence. Field observations made by the writer suggest that such is the case, and that the use of vaccines of chicken-pox origin only produces passive immunity in such outbreaks.

Mosquitoes carry the pox virus, according to many investigators, including Matheson, Brunett, and Brody,[49] and Brody.[50] This fact may help to explain why some outbreaks occur, especially in young poults not fully fledged.

Symptoms and Autopsy Findings.—The first indication is the appearance of minute yellowish eruptions on the dewlap, caruncles, and other head parts (fig. 19). They are soft and in this pustular stage easily removed, leaving an inflamed area covered with a sticky serous exudate. The corners of the mouth, the eyelids, and the mouth membranes (fig. 20) are commonly affected. The lesions enlarge and become covered with a dry scab or a wartlike mass of yellowish-red or brown color. The number of lesions depends on the virulence of the disease. In young poults the head, legs, and feet may be completely covered with pustules. The disease may even spread to the feathered parts of the body (fig. 21).

Brandly and Dunlap reported two cases in 3-week-old poults in which the foot pads and foot webs were involved. Large wartlike processes developed which made it difficult for the poults to walk. Except for a lesion in the corner of the mouth in one poult the disease was

[45] Tietz, G. Ueber die Empfänglichkeit verschiedener Vogelarten für eine Infektion mit originärem Hühner- und Taubenpocken-virus. Tierarztlich Hochschule, Berlin, Archiv für Tierheilkunde. 65:244. 1933.

[46] Coronel, A. B. Fowl-pox vaccine from virus of turkey origin. Philippine Jour. Anim. Indus. 1:85–90. 1934.

[47] Brandly, C. A., and G. L. Dunlap. An outbreak of pox in turkeys with notes on diagnosis and immunization. Poultry Sci. 17(6):511–15. 1938.

[48] Beaudette, F. R., and C. B. Hudson. Egg propagation of turkey pox virus. Poultry Sci. 20(1):79–83. 1941.

[49] Matheson, R., E. L. Brunett, and A. L. Brody. The transmission of fowl pox by mosquitoes—preliminary report. Poultry Sci. 10:211–23. 1931.

[50] Brody, A. L. The transmission of fowl pox. New York (Cornell) Agr. Exp. Sta. Memoir 195:1–37. 1936.

confined to the feet. In these instances the infection was apparently introduced when the owner toe-punched the poults for identification purposes.

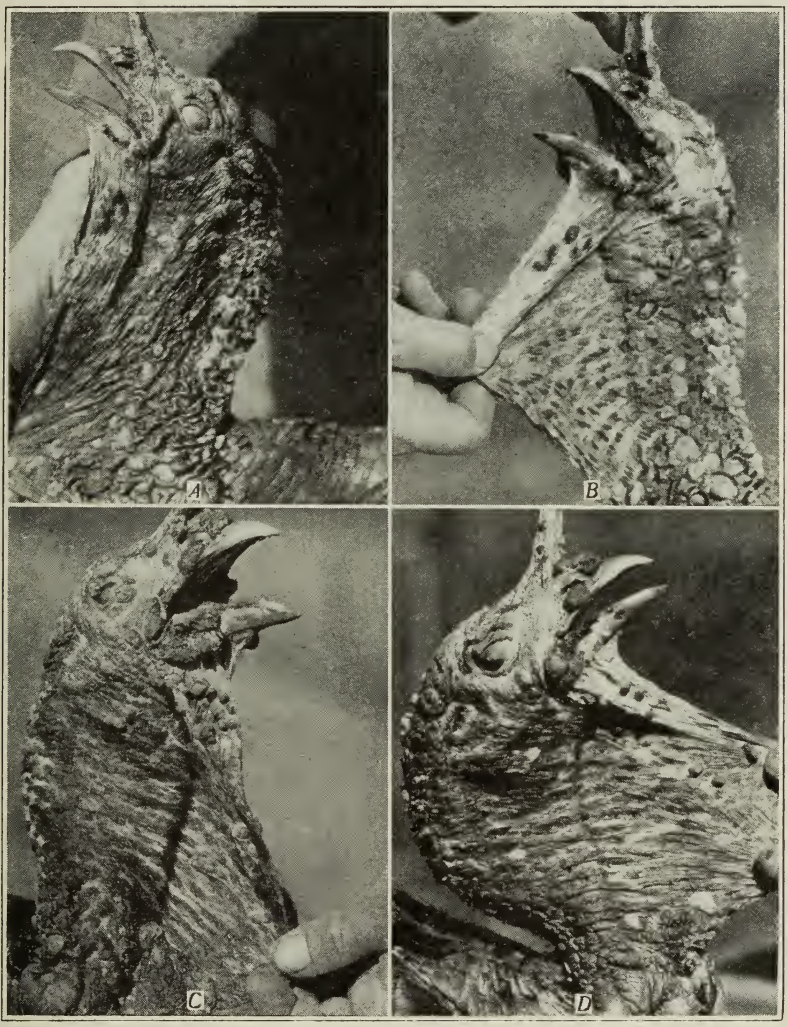

Fig. 19.—Development of fowl-pox lesions in a turkey: *A*, taken when the lesions were first observed; *B* and *C*, at 1- and 2-week intervals; *D*, taken 4 weeks after *A*. Within 10 days after *D* was taken the lesions had disappeared, but the bird remained blind in the left eye.

Males often suffer more than females from the disease, probably because of their inclination for fighting, which spreads the infection through small lacerations.

The mouth parts, the tongue, the esophagus, and occasionally the crop may be covered with masses of soft, yellow cankers closely adhering to the mucous membranes (fig. 20). These yellow, diphtheritic ulcers of fowl pox must be differentiated from the small, deep-seated, irregular, diphtheritic ulcers or cankers often seen in the mouths of turkeys and not associated with typical head lesions. These cankers are common in turkeys that have been vaccinated against fowl pox or that have recovered from an outbreak. Their cause is not known.

Frequently, during the breeding season, atypical cases of fowl pox appear in adult turkeys which have been vaccinated with chicken-pox

Fig. 20.—Fowl-pox lesions in mouth and esophagus.

vaccine several months previously. In these outbreaks, which usually involve only a small percentage of the birds, the mucous membranes of the eyes and the mouth are the principal parts affected. Externally, no lesions in the eyes may be visible; but when the inner surfaces of the lids are examined, soft yellow diphtheritic ulcers will be found to be the cause of the increased lacrimation and inflammation of the eye. Typical yellow cankers described above characterize the mouth lesions. There are no internal lesions that are characteristic of the disease.

Course and Mortality.—There is a marked difference in the severity of cases of fowl pox in turkeys and, consequently, in the course of the disease. Whereas mild cases may clear up in 2 or 3 weeks, severe outbreaks often last for 6, 7, or even 8 weeks. The canker or mouth types take longer to clear up. In such cases, starvation is the cause of death. Blindness often occurs, after the closing of the eyes by severe infection of the eyelids. When the eye is involved, a yellowish cankerlike lesion develops on the mucous membrane of the lid.

The flock mortality is usually low, most of the losses being caused by blindness or starvation. Setback in development and loss in weight are of greater financial importance in the growing flock than the loss in deaths. As outbreaks commonly occur a few days or weeks before market time, it is often necessary to postpone killing the birds for several weeks. If the flock escapes an outbreak before market time, the disease sometimes appears in the breeding flock and causes severe losses through lowered egg production and poor fertility.

Fig. 21.—Fowl-pox lesions on the skin of breast of an adult turkey hen. The head parts were also badly affected.

Prevention.—Vaccination with live-virus vaccine, together with the usual sanitary program, is the recommended method of preventing fowl pox in turkeys. The problem differs from that in chickens because in the latter the effect of the disease and vaccination on egg production must be considered in the preventive program, while in the former a meat-producing bird only is involved. Furthermore, according to data collected by the writer on several thousand turkeys over a six-year period, healthy turkeys respond to vaccination, even when virus of chicken origin is used, with little or no systemic disturbance, such as sometimes follows vaccination of chickens. Consequently there is no need for using a less virulent strain of virus—for example, one of pigeon origin.

Vaccines of chicken-pox origin produce immunity in turkeys for several months. It has been found advisable, however, to revaccinate all birds to be kept for breeders when they reach 5 or 6 months of age as a protection against the disease during the breeding season.

All of the common methods of inoculation of the vaccine have been found equally efficient when properly followed.

Need for Vaccination.—Fowl pox is so widespread in California that yearly vaccination of all turkey flocks is a good insurance policy. The one exception to this general recommendation is the flock well isolated from all chicken flocks and located in a community where the disease does not exist. Since the vaccine used for immunizing a flock contains live virus, capable of spreading the disease, it cannot safely be introduced into a flock or a community where fowl pox is unknown.

The disease is probably carried to new areas by mosquitoes, birds, visitors, animals, secondhand feed sacks, and the introduction of new stock. Turkey growers who do not vaccinate should keep a constant watch for the first appearance of lesions and should immediately obtain advice on the best plan of control.

Age for Vaccination.—There are considerable data to indicate that healthy turkeys can be vaccinated at any age. Dunn and Sherwood[51] have successfully vaccinated day-old turkeys. Many California growers have vaccinated successfully at 6 or 8 weeks of age; the majority, however, at 10 to 12 weeks.

Extreme care must be taken when it is necessary to vaccinate very young poults, to prevent the vaccine from getting on parts of the body other than the area to be treated. Sometimes a careless operator, after spilling vaccine, holds the poult's head with his contaminated hand. The young, tender skin is so susceptible that a severe case of generalized pox may follow.

As it requires from 4 to 8 eight weeks for the vaccination lesion (take) to disappear completely, turkeys should be vaccinated at least 8 weeks before market time. July, August, and early September are desirable months for vaccination in most sections of California. Ample time is then allowed for the flock to develop immunity before the period of the greatest danger of infection, namely, October to June, and for the vaccination area to heal before any birds are killed for market.

As stated above, it is advisable to revaccinate all turkeys kept for breeders before they are put in the breeding pens, or in case of very early-hatched birds (December or January) within six or seven months following the first vaccination.

[51] Dunn, R. C., and R. M. Sherwood. Immunization of day-old chicks and poults against fowl pox. Poultry Sci. 12:323–24. 1933.

Purchase and Care of Vaccine.—Vaccine, not being a stable product, should be purchased only from reliable sources. If it cannot be obtained from a local veterinarian, the county farm advisor's office will probably have a list of available sources. It must be kept and used strictly according to directions given by the manufacturer and must be stored in the refrigerator when not in use. One-half day's supply only, of the concentrated product, should be diluted at one time; and this should be protected against undue heat and exposure to the sun's rays. In hot weather it is advisable to dilute only enough of the concentrate for an hour's use unless the diluted portion can be kept packed in ice. All diluted vaccine not used during the time for which it was prepared should be discarded.

Disinfectants should never be added to the vaccine, nor should the container for vaccine be rinsed in a disinfectant unless it is later rinsed well with water and dried before use. Instruments and brushes for applying the vaccine should not be kept in disinfectants unless they can be thoroughly rinsed before being used. When the stick method is employed, the knife point should be wrapped daily with clean tape.

Technic of Vaccination.—There are two general methods of applying the vaccine: the feather-follicle and stick, or puncture, methods. The feather-follicle method consists in pulling a few feathers and inserting the vaccine, with the aid of a brush, into the feather follicle. The stick method consists in pricking the skin with a sharp instrument previously dipped in vaccine. A modification of the puncture method is the scarification method, in which the skin is scarified, or scratched, with a roughened metal surface that also serves to carry the vaccine into the injury.

Some modification of the stick method is most common today, and it has many advantages over the feather-follicle method, among them being economy in the use of vaccine, greater speed in the application of vaccine, and better control of the amount of vaccine inserted and of the number of lesions or "takes" produced.

At this station, careful comparisons have been made on the immunity developed by applying the vaccine to the skin of the leg, the skin of the wing web, the caruncles, and the skin of the breast. There were no marked differences in immunization.

The skin of the upper thigh has definite advantages over other sites for routine vaccination (fig. 22): these are easy accessibility to the operator, absence of feathers, and inaccessibility to the vaccinated birds or their penmates. The last point is important from the standpoint of the spread of fowl pox by fighting before immunity has been established.

It is advisable to vaccinate on the wing web because turkeys have a habit of picking at the vaccinated area, which may cause spread of the

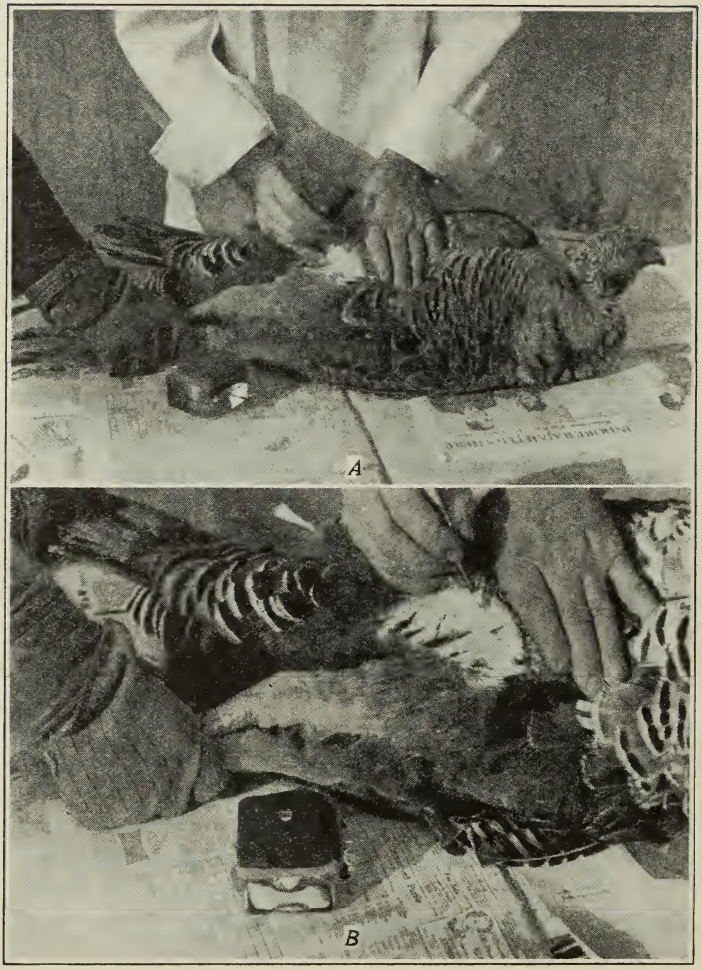

Fig. 22.—*A*, Restraint of turkey for vaccinating on upper thigh. Note that the table is covered with newspapers, to aid in preventing undue spread of vaccine. *B*, A close-up, taken to show the suggested location. The long tuft of feathers that normally covers this naked area is being held back by the vaccinator's left hand. The heavy glass inkwell is a convenient holder for the vaccine. To prevent excessive dust contamination, it is covered with a piece of rubber in which is cut a small opening.

virus to the head and over the wing-web area (fig. 23). This is especially true in very young poults.

The large caruncles at the base of the unfeathered part of the head furnish a convenient area for vaccinating and for observing later the results of vaccination (fig. 24, *C*). On the other hand, this area has two disadvantages because of its proximity to the most susceptible parts of

the body and its open exposure to other turkeys. No serious spread from this site of vaccination, however, has been observed; and the immunity conferred has been as good as in any other vaccination area.

A site for vaccination which is adaptable to certain conditions is the small web of skin between the first digit of the wing and the metacarpus

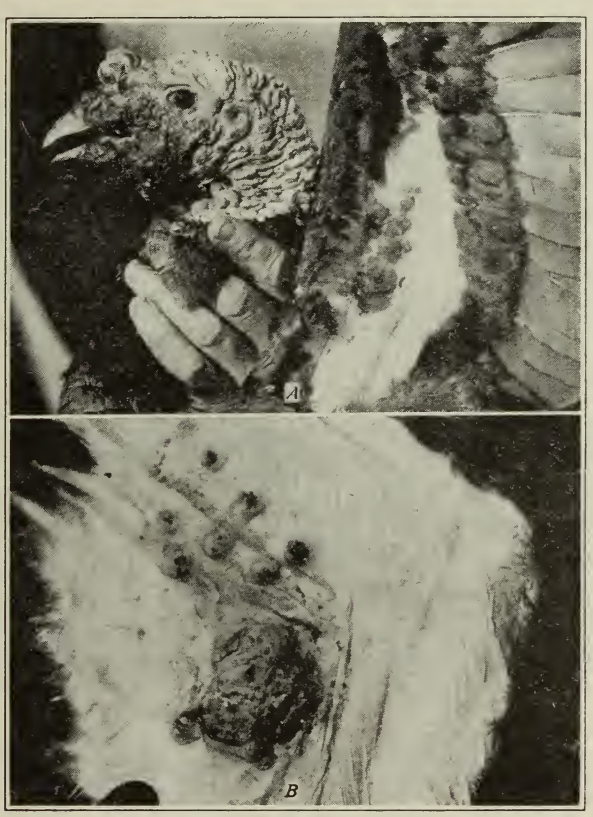

Fig. 23.—*A*, Wing-web vaccination. This picture, taken about 6 weeks after vaccinating in the wing web by a single stab of the inoculating knife, shows how the disease spread from this single inoculation to other areas on the wing and head. The bird died within a few days after the picture was taken. *B*, Close-up of *A* at a somewhat earlier stage.

(fig. 24, *A*). This area is suggested when, for some reason, vaccination has been delayed until 3 or 4 weeks before market time. A small unhealed vaccination scar on this spot will not impair the value of the bird when it is graded for market. Being less convenient than the leg, however, this location is not recommended for routine purposes.

There are many methods of applying the vaccine by the stick method,

but the principle is the same for all of them. Figure 25 shows two suitable instruments, together with a good brush for use in the feather-follicle method. One instrument is made from a Bard-Parker knife (no. 3 handle with no. 11 blade) by wrapping the end first with a small piece of cotton and then with a strip of adhesive tape so that about $\frac{1}{16}$ inch of the point is exposed. This allows point enough for pricking the skin and for making a small incision. The cotton and adhesive tape serve as

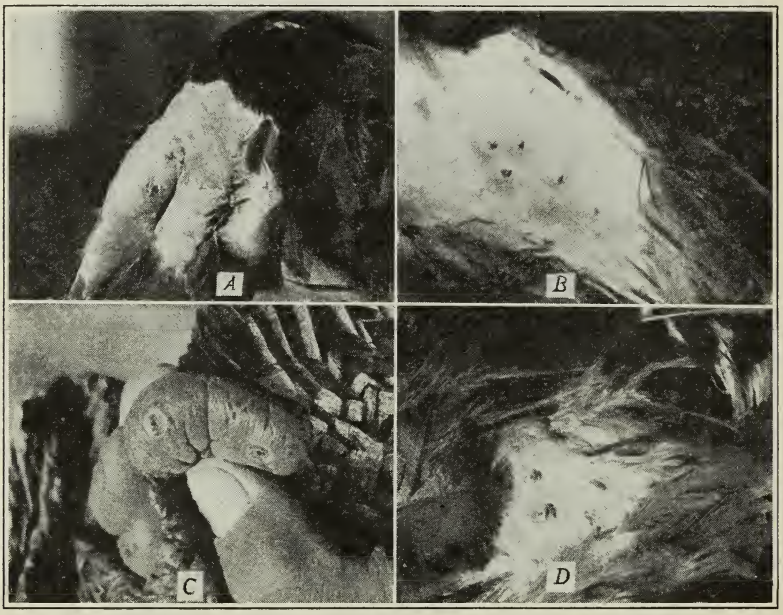

Fig. 24.—Types of "takes" obtained after vaccination in the different areas: *A*, "first finger" of the wing with two inoculation "takes" a week after inoculation by the puncture method; a slight swelling of this appendage is usually noted; *B*, results of feather-follicle vaccination; four follicles a week after vaccination show typical swelling and scab formation; *C*, caruncle showing two "takes" by the puncture method a week after inoculation; *D*, results of puncture inoculation on the skin of the leg.

a reservoir for vaccine and prevent the operator from inserting the knife too far through the skin. The second instrument is one made by inserting two phonograph needles in the end of a suitable holder and wrapping and padding them with cotton and thread. A third type of instrument, not shown in the illustration, consists of a small darning needle with the eye end ground off to leave two sharp prongs with an opening between them for holding a small drop of vaccine. Such a modified needle can be inserted in a suitable handle and has the advantage of inoculating consistent doses of the vaccine. Manufacturers often furnish modifications of these instruments with their vaccine.

The method used in handling the turkeys will, in large measure, determine the number that can be vaccinated in a day. There are many ways of organizing the work, but for large flocks two adjoining corrals with a chute between them for confining a few birds in close quarters are essential (fig. 26). *The fences must be turkey-tight so that unvaccinated birds will not escape into the vaccinated group.* A table at a location convenient to the catching chute provides a good surface for holding the bird, as well as the vaccinator's apparatus (fig. 26, *B*). A helper may hold the turkey and expose the area to be vaccinated, so that the operator need not touch the bird. *Helpers should avoid handling*

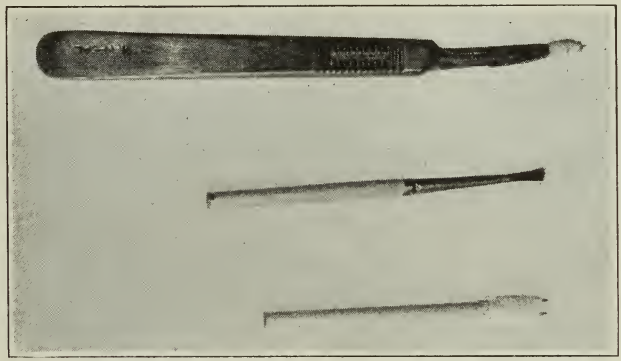

Fig. 25.—Types of instruments in common use for vaccinating against fowl pox.

the vaccine, and every precaution should be taken to prevent its being spilled. One good plan is to keep the vaccine container and the instruments on a newspaper spread over the table (fig. 22). This paper can be rolled and burned at the end of the vaccinating period.

If the upper-thigh location is used for the site of vaccination, the helper holds the feet of the bird with his right hand as shown in figure 22. The vaccinator pulls back the feathers lying along the thigh to expose the skin, inserts the instrument (which has been dipped in the vaccine) into the skin, and makes a very slight incision. If the single-point knife is used, this procedure is repeated once or twice, at places ½ to 1 inch apart, without renewing the vaccine. Two or three punctures of the skin are ample. The helper then places the bird in the vaccinated quarters. The helper can also expose the vaccination area for the vaccinator, but he should avoid getting his hands into the vaccine in allowing the tuft of feathers to fall back into place. After each inoculation, the vaccinator mixes the vaccine thoroughly, using his operating instrument, which at the same time picks up a new supply of vaccine for the

next inoculation. *The most important points to be kept in mind during vaccination are to use fresh, potent vaccine and to be certain that the vaccine is inserted into an injured skin.* Accuracy should not be sacrificed for speed.

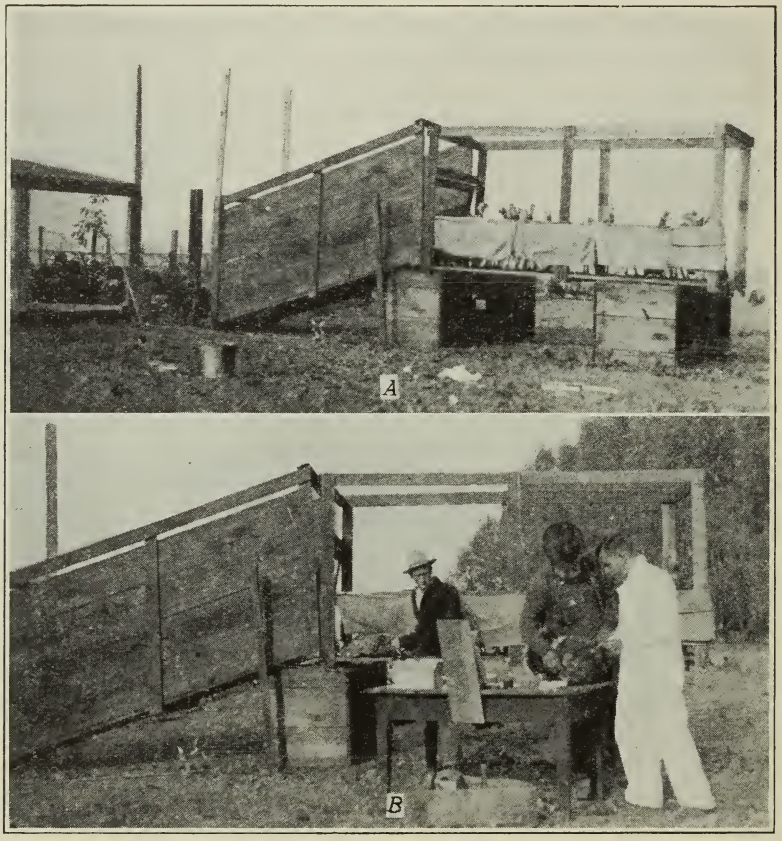

Fig. 26.—*A*, One type of catching chute for handling large numbers of turkeys for vaccination, blood collecting, or other purposes. *B*, The same setup showing how a bird can be removed from the side, by reaching through the burlap "fence," without disturbing the other turkeys. A convenient type of table for restraining the birds and holding the equipment is also shown.

The general location mentioned above also can be used if the feather-follicle method of inoculation is preferred. Not over 4 or 5 feathers should be pulled, and care should be taken to be sure that vaccine has been brushed into the follicle. The small baby-feather follicles are as sensitive to the vaccine as the large pin-feather types.

All unused vaccine, together with the containers, should be burned or placed in disinfectant for several hours to prevent the spread of virus.

All cotton, tape, and thread wraps and papers should be removed and burned. Instruments should be put in some good disinfectant for several hours and then thoroughly rinsed with boiled water, or they may be boiled for 10 minutes.

Post-Vaccination Care of the Flock.—If the flock is in good healthy condition, it need receive no special care after vaccination. Sometime between the eighth and the twelfth day, at least 25 per cent of the flock should be examined to determine whether the vaccination has been successful. If all of the birds in such a sample have one or more vaccination takes (fig. 24), the flock can be considered properly immunized. *If not all have reacted, the entire flock should be handled, and the nonimmunized birds should be revaccinated with a fresh lot of vaccine.* As the birds cannot be considered immune until about a month after vaccination, precautions should be taken to prevent introduction of the disease until after that period. A few vaccinated birds may develop lesions on the head, but these usually clear up within a short time without any severe symptoms. It is well, however, to isolate such birds from the remainder of the flock to prevent spread by fighting before immunity is established.

Reasons for Failure of Vaccination.—Each year, many letters ask why flocks that have been vaccinated have shown no takes when handled in 8 or 10 days after vaccination. The chief reasons for such failures are listed below:

1. Faulty care of vaccine after it leaves the manufacturer:
   a) Undue exposure to heat in shipment.
   b) Improper care by the dispenser (feed store, druggist, veterinarian) or by the purchaser.

2. Use of old vaccine kept beyond the manufacturer's expiration date.

3. Improper use of diluted vaccine:
   a) Undue exposure to heat or sunlight.
   b) Failure to make up fresh supplies at short intervals.
   c) Failure to keep the vaccine well mixed.
   d) Attempts to economize by greater dilution than recommended by the manufacturer.

4. Inefficient inoculation:
   a) Failure to dip the instrument into the vaccine after each inoculation.
   b) Failure to separate the feathers properly to expose the skin, with resultant loss of a large part of the vaccine as the instrument passes through the feathers.
   c) Failure to make an incision in the skin.

5. Sacrifice of accuracy for speed.

6. Previous immunity because of former outbreak or because of natural resistance.

Control of an Outbreak.—If fowl pox appears in a flock, the following procedure is recommended:

1. Isolate all birds showing lesions.
2. Vaccinate as soon as possible all birds not showing lesions.
3. Place infected birds in warm, dry quarters if available.
4. Separate the males or keep careful watch over them to prevent fighting.
5. Treat infected birds individually by removing the scabs and touching the wounds with iodine, if time permits and the expense warrants it. An iodine ointment such as Iodex applied liberally over the infected area will aid in reducing the spread of the disease and will shorten the period of convalescence. Saturated boric acid solution is recommended for washing the eyes.
6. Individual feeding of valuable birds with the aid of a funnel and rubber tubing inserted into the crop may be advisable in severe cases.

Drugs for internal treatment are not recommended. Since loss of flesh and slowed-down development are the chief causes of economic loss in most outbreaks, careful management and attention to the feeding program during and after an outbreak are essential to a speedy return to normal. The course of the disease can be shortened by the use of shelter for roosting and by general protection from damp weather.

FOWL TYPHOID

Fowl typhoid is a septicemic infection caused by *Salmonella gallinarum*. Cultures of this organism isolated from outbreaks among turkeys have resembled bacteriologically those isolated from chickens. Flocks grown in confinement have appeared more susceptible than those raised on open range; and contact with chickens, or yards used by chickens, apparently has been an important factor in the spread of fowl typhoid to turkeys.

Pfeiler and Roepke,[52] Kaupp and Dearstyne,[53] Martinaglia,[54] and Hinshaw[55] have reported the disease in turkeys reared on farms where it was also prevalent in chickens. Evidence that the disease may be transmitted through the egg in the same manner as in pullorum disease is presented by Hinshaw and Taylor.[56] Johnson and Pollard[57] reported

[52] Pfeiler and Roepke. Zweite Mitteilung über das Auftreten des Hühnertyphus und die Eigenschaften seines Erregers. Centbl. f. Bakteriol. I Abt. Orig. 79:125–39. *Abstracted in:* Jour. Comp. Path. 30:263–66. 1917.

[53] Kaupp, B. F., and R. S. Dearstyne. Fowl typhoid—a comparison of various European strains with those of North America. Poultry Sci. 3(4):119–27. 1924.

[54] Martinaglia, G. A note on *Salmonella gallinarum* infection of 10-day-old chicks and adult turkeys. So. African Vet. Med. Assoc. Jour. 1(3):35–6. 1929.

[55] Hinshaw, W. R. Fowl typhoid in turkeys. Vet. Med. 25(12):514–17. 1930.

[56] Hinshaw, W. R., and T. J. Taylor. A chronic carrier of fowl typhoid of turkeys. Amer. Vet. Med. Assoc. Jour. 82(6):922–26. 1933.

[57] Johnson, E. P., and M. Pollard. Fowl typhoid in turkey poults. Amer. Vet. Med. Assoc. Jour. 96:243–44. 1940.

outbreaks in poults with symptoms, mortality, and pathology comparable to pullorum disease. Usually, however, the disease is reported in mature or nearly mature turkeys. Vidovic[58] claimed that strains of the causative organism isolated from turkeys were more pathogenic than strains isolated from chickens. The strains isolated from turkeys by the present writer have appeared identical with those from other fowl.

Symptoms, Course, and Mortality.—Increased thirst, loss of appetite, listlessness, a tendency to separate themselves from the well birds, and diarrhea with greenish to greenish-yellow discharge characterize the disease in the field. The sick turkeys sit around with drooping tails, sagging wings, and heads hung low or carried back over the body and resting on or under the wing. As indicated by the increased thirst, the body temperature rises several degrees, to as high as 112° F, until just before death, when it may drop to as low as 103°.

Often birds die without having shown any previous symptoms, but usually they linger for a day or two after symptoms appear. Several outbreaks may occur in a flock in a single season, or the original one may be acute and last for only a few days. Intermittent outbreaks are more likely to occur if the birds are left on the originally infected premises or have constant contact with carrier chickens or turkeys. The initial outbreak usually causes the heaviest mortality, which is followed by intermittent recurrence of symptoms in a few birds, with a low mortality at each subsequent flare-up of the disease. Although the average mortality in four outbreaks studied was 26.5 per cent, heavier losses have often been reported. One flock owner lost 169 out of 175 turkeys during the fall and winter in intermittent outbreaks.

In very young poults the symptoms, course, and mortality are similar to those of pullorum disease.

Autopsy Findings.—The lesions resemble those observed in chickens. Because of the short duration of the disease, the birds nearly always die in good flesh. The muscles of the breast have a tendency to be congested and often appear as if partially cooked. The heart is usually swollen and contains small grayish necrotic areas or pin-point hemorrhages (petechiae) ; in a few cases both have been observed. The liver is friable and is consistently enlarged to two or three times its normal size; in color it is bronze to mahogany or covered with streaks which are a mixture of these colors. Pin-point areas of necrosis have been noted, though not consistently; and, on cutting, the blood flows readily. The spleen is always enlarged to two or three times its normal size, is friable, and appears mottled. In most birds the lungs appear as if parboiled

[58] Vidovic, F. *Bact. gallinarum* in hen and turkey. (Trans. title.) Centbl. f. Bakteriol. Referate. 103:472. 1930. *Abstracted in:* Internat. Rev. Poultry Sci. 5:94. 1933.

and frequently are more firm than normal, because of minute caseated abscesses. The kidneys are usually enlarged and may show some petechiae.

The crop, as a rule, contains food, which indicates paralysis of the digestive tract, since birds seldom eat after symptoms appear. The mucous membrane of the proventriculus sloughs readily. The gizzard usually contains food, and the lining is easily removed. With a few exceptions the intestine appears anemic when viewed from the exterior,

Fig. 27.—Ovary from turkey hen, showing diseased ova caused by fowl typhoid. There were no normal ova.

and ulcerations of the mucous membrane may be plainly visible through the serous membrane. This ulceration is uncommon, but when present is most severe in the duodenum; a few ulcers from 1.0 to 4.0 millimeters in diameter have been observed throughout the intestine, extending to the ceca.

The enlarged mahogany- or bronze-streaked liver, the enlarged spleen, the area of necrosis in the heart, and the grayish lungs appear to be pathognomonic. Hemorrhagic enteritis, especially of the duodenum, and marked ulceration of the intestine, although uncommon in chickens, are more or less consistent lesions in turkeys. *Salmonella gallinarum,* the causative organism, can readily be isolated from all organs. In birds

that have been dead for some time, pure cultures are more easily isolated from the bone marrow than from the liver, spleen, and heart blood.

Johnson and Pollard described the following autopsy findings for young poults: an increased percentage of large retained yolks; slightly enlarged, somewhat friable livers of a white creamy color, with the surfaces mottled with slight hemorrhagic areas; and slight congestion in the anterior duodenum. The crops, gizzards, and intestines were always devoid of food, a condition which indicates lack of appetite for hours before death.

In adult carriers there is, as in the case of pullorum disease, a predilection for the reproductive organs (fig. 27).

Prevention, Control, and Treatment.—Since chickens are apparently the most common carriers of the disease to turkeys, the two species should never be allowed to mingle. It is equally important to keep turkeys from yards or ranges that have recently been used for chickens.

Survivors of an outbreak should not be kept for breeders, because of the danger of transmitting the disease through the egg. If it is absolutely necessary to keep such survivors, the rigid program of testing which is recommended for eradication of pullorum disease should be followed. The same test will detect carriers of both diseases.

Control depends upon getting rid of the infection in the flock. The removal of all sick birds and the transfer of the well birds to a new range that has not been used for either chickens or turkeys are recommended. One method for separating sick birds from well ones in an acute outbreak is to take the temperatures of all birds in the flock and eliminate those showing temperatures above 108° F. Another means of eliminating carriers, which has proved practicable in stopping intermittent losses, is to bleed the survivors and have the blood tested by means of the tube agglutination test; a diagnostic laboratory should be consulted before testing the flock.

Just before being moved, the birds should be given a laxative, such as a mash containing 40 per cent of dried skim milk fed as the morning feed for 2 days. Epsom salts, if used, should not be given in doses exceeding 1 pound per 1,000 pounds of turkeys. Bran containing 5 per cent of molasses fed as a daily morning feed for a few days is another suggested laxative. Reduction of the protein level for a few days is also recommended.

As the greatest source of the spread of the disease is the droppings, the roosts should be screened so as to prevent the birds from having access to them. Sick birds should be taken out of the flock as soon as noted; frequent changes of the watering and feeding areas should be made; and whenever many new cases appear, the flock should be moved.

Next to the droppings, the greatest sources of infection are the food and water containers. They should therefore be cleaned and disinfected daily or even oftener. In the absence of running water fresh, clean water should be given several times daily. Any antiseptic used should be one that will not make the water distasteful. Antiseptics that prevent the birds from drinking a normal amount of water do more harm than good.

No satisfactory medicinal treatment has been found. Thus far experimental work has not demonstrated that vaccination with fowl-typhoid bacterins is effective for preventing or controlling the disease in turkeys.

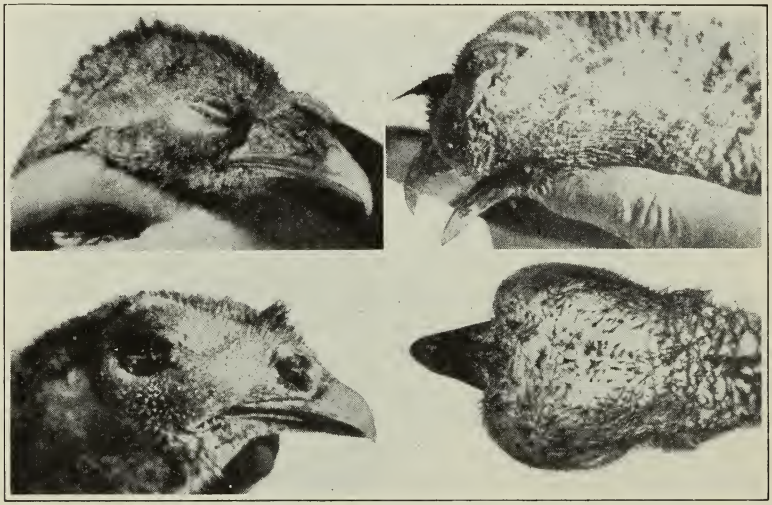

Fig. 28.—Sinusitis experimentally induced by eliminating vitamin A from the ration. The symptoms seen here are identical with those in the contagious type. (From *Hilgardia*, vol. 8, no. 9.)

INFECTIOUS SINUSITIS

(Swellhead, sinusitis)

This disease, which appears to be specific for turkeys, is characterized by inflammation of the infraorbital sinuses, which become distended with a semigelatinous exudate (fig. 28). Madsen[59] and Hart[60] have shown that the disease is transmissible by injection of exudate from infected into normal sinuses of turkeys. Neither was able to reproduce the disease by contact, and Hart failed also to reproduce it by either ocular or intranasal routes. Hinshaw and Bonestell[61] have confirmed the results of these investigators. These workers could not produce the disease in chickens, but were successful in transmitting the disease back

[59] Madsen, D. E. Sinusitis of turkeys. Utah Agr. Exp. Sta. Bul. 280:1–12. 1938.
[60] Hart, L. Sinusitis in turkeys. Austral. Vet. Jour. 16(4):163–68. 1940.
[61] Unpublished data.

to turkeys by injection of saline washings removed from the sinuses of chickens given intrasinal injections a week previous.

The exact etiology of the disease is unknown. Hart states, "The causal agent . . . appears most likely to be a filterable virus although two attempts to pass it through an Elford collodion membrane were unsuccessful." Hinshaw and Bonestell likewise were unsuccessful in transmitting the disease with filtrates of sinus exudates passed through Chamberlain (L–5) and sintered glass filters. A pleomorphic Gram-negative rod has been consistently isolated in pure culture. In only one instance, however, was it possible to transmit the disease by injection of this organism into the sinuses of turkeys. In this one instance the first generation grown on horse-blood agar was used, and there is the possibility that a filterable factor may have been carried over on the medium.

The disease must be differentiated from sinusitis associated with vitamin-A deficiency and from fowl coryza, which Beach and Schalm[62] found to be transmissible to turkeys. Mechanical injury caused by a piece of grain or mash or some other foreign body becoming lodged in the sinus may result in a swollen sinus. As a rule these mechanical cases are unilateral. There is little question that a diet deficient in vitamin A will predispose turkeys to this disease.

Symptoms.—Warnings of the disease are given when birds shake their heads and when discharges are found on the feathers over the wing where the bird has attempted to clean its nostrils. These manifestations are followed by a foaming of the eye secretions and by a marked clear nasal discharge. Swelling of the sinuses and, in advanced cases, a partial to complete closing of the eyes are the principal symptoms that follow these early signs. The appetite remains good as long as the bird can see to eat. As the disease progresses, the affected birds become thin but seldom show other symptoms. Labored breathing, in some cases, results from respiratory involvement or from a complete closing of the palatine opening because of pressure from the exudate in the sinuses.

As these symptoms are characteristic for all types of sinusitis, final diagnosis depends on the history of the case and on autopsy findings.

Course and Mortality.—Sinusitis of the obviously contagious type runs a chronic course and may exist in a flock for weeks. Although the number of deaths may be less than in some more acute diseases, the financial loss may be greater. Failure to gain weight accounts for as much damage as does mortality.

Autopsy Findings.—The filling of the sinuses with exudate, the presence of pneumonia, and pleuritis are manifestations of this disease.

[62] Beach, J. R., and O. W. Schalm. Studies of the clinical manifestations and transmissibility of infectious coryza of chickens. Poultry Sci. 15:466–72. 1936.

Sinusitis usually occurs without involvement of the other respiration passages, but in some flocks inflammatory changes in all the respiratory organs may be noted. In some instances the lesions will be confined to the lower respiratory passages without involvement of the sinuses. Caseated exudate in the air sacs is common in acute outbreaks. When the lungs are affected, the bronchii are chiefly concerned.

The exudate in the sinuses in the first stages is watery in consistency, later becomes semigelatinous, and finally caseated and whitish yellow in color. In typical outbreaks caseation of the exudate is the exception.

In sinusitis associated with vitamin-A deficiency the lesions described under "Avitaminosis A" will also be seen.

Prevention, Control, and Treatment.—Since the exact cause of the disease is not known, no definite preventive recommendations can be given. As environment seems to play a part in its spread, protection of the flock from unnecessary exposure to drafts, windstorms, and sandstorms should be avoided. A diet adequate in vitamin A is also necessary.

Madsen[63] has reported good results in the control of sinusitis by the use of 1 cubic centimeter (about ¼ teaspoon) of a 4 per cent solution of silver nitrate injected into the affected sinus after removal of the exudate with the aid of a hypodermic syringe. Dickinson and Hinshaw[64] as well as Hart (cited in footnote 60, p. 64) have used a 15 per cent argyrol solution in a similar manner with equal success. They also confirmed Madsen's results with silver nitrate.

The method consists in withdrawing the gelatinous exudate from the sinus with the aid of a syringe (5 or 10 cubic centimeter) fitted with a 16-gauge needle, 1½ inches long. In the early stages of the disease this exudate is easily reached and removed when one learns the technic. It consists in inserting the needle through the skin and sinus membranes into the filled sinus. Withdrawal of the syringe plunger will remove the semifluid exudate. The needle is left inserted in the sinus; and, with a second syringe, the remedy (silver nitrate or argyrol) is injected and worked through the tissues by gentle massage. Care should be taken to avoid excessive dosages.

Both these treatments cause considerable swelling of the affected areas; but this subsides within 2 or 3 days, and complete recovery usually takes place within 10 days. In severe cases a second treatment may be necessary.

It is essential to administer this treatment in the early stages of the

[63] Madsen, D. E. Reports success in treatment of roup in turkeys. San Diego Poultry Journal, Oct. 25, 1936, p. 6.

[64] Dickinson, E. M., and W. R. Hinshaw. Treatment of infectious sinusitis of turkeys with argyrol and silver nitrate. Amer. Vet. Med. Assoc. Jour. 93:151–56. 1938.

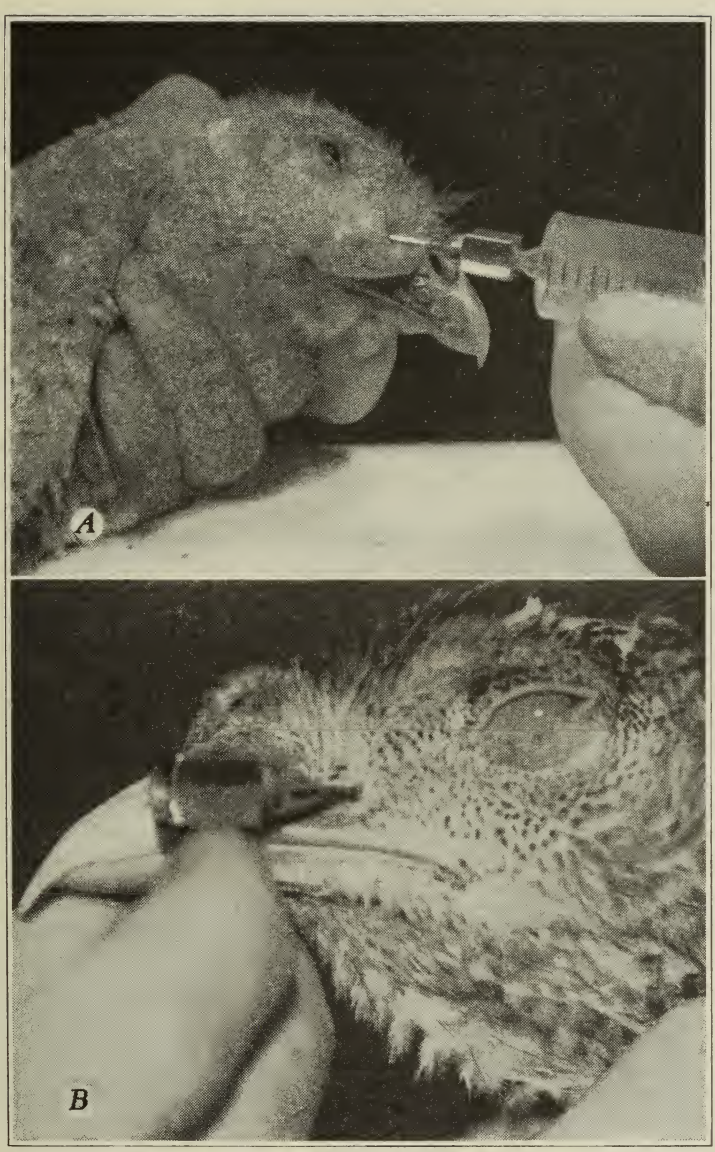

Fig. 29.—Treatment of infectious sinusitis. *A*, Method of insertion of the hypodermic needle into the sinus for withdrawal of exudate and inoculation of remedy. *B*, After withdrawal of the exudate the needle is left in the sinus, until the remedy is inserted.

disease when the exudate is in a semigelatinous state. Figure 29 shows the method of inserting the needle for removal of the exudate and for injection of the remedy.

No satisfactory treatment has been found for the birds that have an involvement of the respiratory organs (bronchii, lungs, and air sacs).

If silver nitrate solution is used, it is advisable for the operator to wear leather or rubber gloves because this remedy is very caustic to the skin.

Surgical removal of the exudate and irrigation of the sinuses with a fresh solution of 15 per cent argyrol or 4 per cent silver nitrate solution may be necessary if the exudate has become caseous. A circular section of skin, at least ¼ inch in diameter, over the swollen area should be removed; and the exudate should be forced out by pressure with the thumb and forefinger. Next, a piece of cotton saturated with the drug to be used can be inserted into the sinus to permit drainage and to prevent excessive dust collection. Care should be taken to avoid undue injury to the lining of the sinus. The treatment should be repeated every few days until improvement is noted.

It is a good plan, at the beginning of an outbreak, to send a representative specimen to a diagnostic laboratory in order to check on the possible presence of other diseases. Treatment is usually less successful than many salesmen lead one to believe, and too much faith should not be placed in remedies guaranteed to cure sinusitis. There is no experimental evidence to substantiate the claims of manufacturers that so-called "roup bacterins" will prevent or cure this disease. Until a specific cause is found and experimental evidence is available, bacterins cannot be recommended.

Although it is not definitely known that turkeys which recover from sinusitis remain carriers the following year, all contact between them and growing poults should be avoided. If a recovered flock must be used for breeding, the eggs should be hatched in an incubator, and the poults brooded artificially. As soon as enough eggs are obtained for producing the desired number of poults, the breeding flock should be put into condition and sold for meat purposes to avoid possible contact with the poults during the rearing season.

PARATYPHOID INFECTION

(Salmonellosis)

Diseases of turkeys caused by members of the *Salmonella* group other than *S. pullorum* and *S. gallinarum* are being reported with increasing frequency in the literature.

Rettger, Plastridge, and Cameron[65] in 1933 were the first in the United States to report outbreaks of salmonellosis in poults. The two outbreaks described by them occurred in New England and were caused by *Salmonella typhimurium*. In 1936, Lee, Holm, and Murray[66] reported on 11 acute outbreaks occurring on midwestern farms; and in 1937, Cherrington, Gildow, and Moore[67] reported outbreaks from Idaho. No attempts were made by the last two groups of investigators to antigenically type the strains isolated by them, but evidence presented indicates that the outbreaks were due to *S. typhimurium*.

Edwards[68] in 1937 reported the isolation of *Salmonella senftenberg* from turkeys. In 1939[69] he reported the indentification of 11 species sent to him by American investigators from 31 outbreaks in turkeys.

A total of 20 species or types of *Salmonella* other than *S. pullorum* and *S. gallinarum* isolated from California outbreaks have been studied at this station.[70] These are as follows:

S. typhimurium	*S. bareilly*	*S. newington*
S. typhimurium var. *copenhagen*	*S. montevideo*	*S. meleagridis*
S. california	*S. newport*	*S. newbrunswick*
S. derby	*S. panama*	*S. senftenberg*
S. bredeney	*S. anatum*	*S. kentucky*
S. oranienburg	*S. give*	*S. worthington*
	S. lexington	*S. sandiego*

Salmonella typhimurium was responsible for approximately 70 per cent of the outbreaks studied. Of Edwards' list all, except one, *S. minnesota,* are included in the above list from California. Pomeroy and Fenstermacher[71, 72, 73] have added to these *S. enteritidis, S. chester, S. wichita, S. eastbourne, S. litchfield, S. saintpaul, and S. illinois.* Edwards reported (personal correspondence, November, 1941) four additional strains, *S. thompson, S. oregon, S. manhattan, and S. amherstiana,*

[65] Rettger, L. F., W. N. Plastridge, and Ruth Cameron. Endemic paratyphoid infection in turkeys. Jour. Infect. Dis. 53:272–79. 1933.

[66] Lee, C. D., Glen Holm, and Charles Murray. Paratyphoid infection in turkeys. Amer. Vet. Med. Assoc. Jour. 89:65–76. 1936.

[67] Cherrington, V. A., E. M. Gildow, and P. Moore. Paratyphoid in turkeys. Poultry Sci. 16:226–31. 1937.

[68] Edwards, P. R. The occurrence of *Salmonella senftenberg* type, in a disease of turkeys. Jour. Bact. 33(2):193–95. 1937.

[69] Edwards, P. R. Incidence of *Salmonella* types in United States. Proc. 7th World's Congress, Cleveland, Ohio. July 28–Aug. 7, 1939:271–74. 1939. Waverly Press, Baltimore, Maryland.

[70] The writer is indebted to the California State Department of Agriculture Laboratories for furnishing cultures from outbreaks for identification and to T. J. Taylor, University of California, and P. R. Edwards, University of Kentucky, for aid in their identification.

[71] Pomeroy, B. S., and R. Fenstermacher. Paratyphoid infection of turkeys. Amer. Vet. Assoc. Jour. 94:90–96. 1939.

[72] Pomeroy, B. S., and R. Fenstermacher. Paratyphoid infection of turkeys. Amer. Jour. Vet. Res. 2:285–91. 1941.

[73] Pomeroy, B. S., and R. Fenstermacher. Salmonella infections of breeding turkeys. *Abstracted in:* Amer. Vet. Med. Assoc. Jour. 99:216–17. 1941.

which makes a total of at least 32 strains in addition to *S. pullorum* and *S. gallinarum* reported to date from turkeys in the United States.

It will be seen from this list of California isolated species and from the reports of other investigators that the problem of salmonellosis in turkeys is a complicated one, especially from the standpoint of eradication with the aid of the agglutination test. The fact that *Salmonella typhimurium* is the most common species found in turkeys complicates the problem even more, because this species is also common to many other hosts, including other domestic fowl, wild birds, rodents, some farm animals, and even man. Many of the species found in turkeys have been found first in food-poisoning outbreaks in man. Therefore, any plan for the control and prevention of salmonellosis in turkeys must include the control in man and other animals as well.

Transmission.—Evidence that this group of diseases may be transmitted through the egg, in the same way as pullorum disease, has been presented by Cherrington, Gildow, and Moore (cited in footnote 67, p. 69), who succeeded in isolating *Salmonella typhimurium* from two of six ovaries removed from reacting turkeys, and from three of 30 "dead-in-shell" embryos. Lee, Holm, and Murray (cited in footnote 66, p. 69) in an earlier paper reported the isolation of this organism from four of ten ovaries removed from artificially infected turkey hens. At this station *S. typhimurium* has been isolated from both the ovary and oviduct of turkey hens. The incidence of *S. typhimurium* in eggs laid by carriers is not high, according to the literature available and from the present writer's experience.

Pomeroy and Fenstermacher (cited in footnote 72, p. 69) report the isolation of paratyphoid organisms from 7 out of 200 incubated eggs that failed to hatch. *Salmonella typhimurium* was isolated from the ovaries of 2 of the 9 reactors that laid the above-mentioned eggs. In 1941 these investigators showed that *S. typhimurium* will pass through the unbroken shell and infect developing embryos, some of which hatch and become a source of infection to normal poults. Schalm[74] earlier showed that this same method of infection is possible in chicken eggs. Therefore, in addition to ovarian transmission, transmission by eggs infected by fecal matter in the passage of the egg through the cloaca is apparently possible. In fact, from information available it would seem that this method is more common than by the former method.

Symptoms.—The symptoms in young poults are indistinguishable from those of pullorum disease. The age at which poults may be affected ranges from a few days after hatching to maturity. In general, however,

[74] Schalm, O. W. Study of a paratyphoid infection in chicks. Jour. Infect. Dis. 61:208–16. 1937.

the age incidence is that of pullorum disease—from 3 or 4 days of age to one month. The age at which the disease is first observed in poults will depend on whether the poults are infected while in the incubator or after being placed in the brooder. In one outbreak studied, symptoms were seen 2 days after the poults were taken from the incubator, indicating transmission in the incubator soon after the eggs started to hatch.

Diarrhea in young poults is not a constant symptom; often poults normal in the evening may be found dead in the morning. Where death is delayed for several days, weakness, unthriftiness, sagging wings, and diarrhea are characteristic symptoms. Many poults that survive for several days will become emaciated, and the feathers around the vent will be matted with fecal matter.

In older turkeys, loss of appetite, unthriftiness, loss of flesh, and a general unkempt appearance have been the symptoms most commonly observed. Diarrhea may or may not be in evidence. Death usually follows after several days of sickness.

Autopsy Findings.—Inflammation of the duodenum, congestion of the liver, kidney, gall bladder, and heart muscle are the most constant post-mortem findings. The pericardial sac is often filled with a serous straw-colored fluid. Another common finding is a cecal plug similar to that sometimes seen in pullorum disease. Lung and heart lesions are rare.

In adult turkeys a marked inflammation of the intestine, with occasional necrotic ulcers, is seen. The liver and spleen in these cases is usually swollen and congested. Diagnosis depends on isolating and identifying the causative organism.

Prevention and Control.—Prevention consists in obtaining stock which is free of the disease, and in keeping the birds from being exposed to other animal reservoirs of infection. As stated before, many of the species of *Salmonella* responsible for losses in turkeys are also prevalent in other animals and even in man. Thus the prevention program must be extended to all animals on the ranch. Eradication of rats and mice is essential to prevention of this group of diseases. If the disease is diagnosed in any group of poults, the poults should be reared separately from other groups, and sold for market. Such infected groups should never be used for breeders.

The use of the agglutination test as an aid in determining the presence or absence of the disease on the premises will depend on the facilities available for getting such tests made. If a diagnosis of the disease has been made and the species of *Salmonella* determined by a reliable laboratory, the agglutination test may be used if made by a laboratory thoroughly familiar with the problems connected with the conduction of paratyphoid agglutination tests. Each ranch has to be handled as an

individual unit, when making plans for testing. A separate test must be made for each species isolated, and the complete knowledge of the disease history of the flock is essential to a successful program. The agglutination test for the paratyphoids is more complicated and, as now conducted, more subject to variation than is the one for pullorum disease. To properly conduct it, the laboratorian must be thoroughly familiar with the antigenic structure of the *Salmonellas* and be able to accurately interpret results. On ranches where the infection is known to exist, the test may be a valuable adjunct in the prevention program, but must be considered only as one part of such a program. It is absolutely necessary to know the species causing the disease; and, as may often be the case, there may be two or more species responsible (see Edwards and Bruner[75]). If the complete history is known and a competent laboratory is available, testing is advised. A general testing program for the paratyphoids will probably never be possible because of the multiplicity of species affecting turkeys. Every effort should be made to prevent any of the paratyphoids from getting into breeding flocks. The destruction of broods suffering from the disease, with purchase of replacements from sources known to be free, is one plan which can be used.

Hatcheries and egg-selling groups can help prevent the group of diseases from spreading by keeping thoroughly familiar with all the ranches furnishing hatching eggs. Frequent use of diagnostic laboratories is urged during the brooding season in order to insure a high percentage of diagnoses of the outbreaks of paratyphoid which occur. Whenever a diagnosis is made, the owner should be made familiar with the problem and responsibility he has in preventing the spread of the disease. Often only one brood is affected, and it will be good insurance to destroy all the survivors. In any case, survivors of an outbreak should not be normally used for breeding purposes. If the flock has to be used for breeders, it should be tested (using the same species isolated) and retested at frequent intervals, until no reactors are found. Competent advice should be sought to determine the proper procedure to follow. Other animal and bird reservoirs on the ranch must also be eliminated if the disease is to be eradicated.

No satisfactory treatment is known. Until more is known about the efficiency of bacterins for prevention and control, they cannot be recommended. The multiplicity of species makes the general use of bacterins as impossible as a generalized testing program at the present time, and growers are warned against their promiscuous use.

[75] Edwards, P. R. and D. W. Bruner. The occurrence of multiple types of paratyphoid bacilli in infections of fowls with special reference to two new *Salmonella* species. Jour. Infect. Dis. 66:218–21. 1940

PULLORUM DISEASE

This disease, caused by *Salmonella pullorum,* has been increasing in economic importance to the turkey industry since the advent of the commercial hatching of turkey eggs. It was first described by Hewitt[76] in Minnesota in 1928. It has since become widespread among turkeys in America as well as in some of the other countries of the world. Comprehensive reviews of the literature have been given by Brunett,[77] Tittsler,[78] Johnson and Anderson,[79] and Hinshaw.[80] Investigators in other countries who have reported on the disease in turkeys include Dalling, Mason, and Gordon,[81] Jansen,[82] and Barboni.[83]

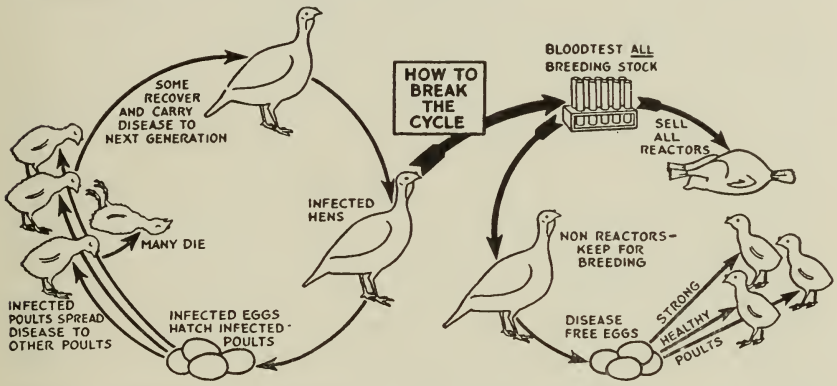

Fig. 30.—Showing the cycle of infection in pullorum disease and the possibilities of breaking the cycle with the aid of the agglutination test. (Courtesy of *Turkey World.*)

Previous to 1938, when Johnson and Anderson reported an outbreak which apparently originated from eggs laid by turkey carriers, all the evidence pointed to chickens as the main source of the infection in turkeys. The disease is now, however, well established in many turkey flocks; and the cycle of infection has been shown to be identical with that for chickens (fig. 30).

[76] Hewitt, E. A. Bacillary white diarrhea in baby turkeys. Cornell Vet. 18:272–76. 1928.

[77] Brunett, E. L. Pullorum disease in the mature turkey. Poultry Sci. 9:356–60. 1930.

[78] Tittsler, R. P. Pullorum disease in poults. Poultry Sci. 11:78–80. 1932.

[79] Johnson, E. P., and G. W. Anderson. Pullorum disease in turkeys. Jour. Infect. Dis. 58:337–48. 1936.

[80] Hinshaw, W. R. Pullorum disease of turkeys. National Poultry Improvement Plan Conf. Proc. (Cleveland, Ohio, June 8–9, 1939). U. S. Dept. Agr. Mimeo. p. 98–104. 1939.

[81] Dalling, T., J. H. Mason, and W. S. Gordon. Bacillary white diarrhea (B.W.D.) *B. pullorum* isolated from a turkey poult in England. Vet. Rec. 9:902. 1929.

[82] Jansen, J. Chronische pullorum—infectie bij volwassen kalkoenen. Tijdschr. v. Diergeneesk. 59:1047–49. 1932.

[83] Barboni, E. Ricerche sul primo focolaio di pullorosi nei tacchini riscontrato in Italia. La Clinica Vet. 60(10):597–613. 1937.

Symptoms.—The symptoms in poults are identical with those described for chicks. The disease is usually very acute, and many poults die without showing any noticeable symptoms. Poults that show symptoms seem cold and sit around the hot part of the hover space. Their wings sag, their heads hang, and their feathers appear unkempt. The skin over the feet and legs usually appears dry and somewhat wrinkled. Diarrhea may or may not be in evidence; but in most of the cases that are prolonged for 2 or 3 days, diarrhea is indicated by the pasting of the down around the vent. Labored breathing, due to pneumonia, is commonly observed.

Course and Mortality.—Most of the losses occur during the first 3 weeks after hatching, and may start as early as the second day. It is not uncommon for relapses to occur at any time up to maturity, with varying degrees of mortality. Frequently when survivors of an early-age outbreak reach 9 to 10 weeks of age and are transferred to a growing ration or moved to new quarters, a second outbreak occurs with a subsequent mortality of 5 to 15 per cent. Such relapses may also occur as a complicatory factor in outbreaks of infectious catarrhal enteritis. The diagnostic laboratories of the California State Department of Agriculture have reported several outbreaks in turkeys 3 to 6 months of age. Losses of this age group have as a rule been small. Subacute outbreaks have also been experienced in breeding flocks after they are in production. Such outbreaks are attributed to transmission by eating infected eggs and to subsequent spread by the intestinal shedders that became infected. Losses are usually small.

The mortality in poults under 1 month of age varies from less than 10 to as high as 100 per cent of a brood, according to the virulency of the organism and the management of the brood. In 32 outbreaks studied by the writer there were 19,647 poults, and the average mortality was 34.5 per cent. The maximum mortality was 100 per cent in a brood of 25 poults; the minimum was 12 per cent in a brood of 1,250.

Autopsy Findings.—There are a few distinctive changes in poults that have died from pullorum disease. Minute caseous abscesses in the lungs and heart muscles similar to those seen in chicks are the most characteristic lesions. Similar abscesses may be found in the gizzard muscles. The intestines usually lack tone, and contain an excessive mucus discharge. Cecal cores are seen, but are not pathognomonic for this disease alone. The liver is commonly congested and swollen or may be of an ochre to a bronze color, streaked with areas of congestion. Pinpoint areas of necrosis are also common.

The post-mortem findings in partially grown poults are similar to those seen in younger ones, but are generally less pronounced. Lung

lesions are only occasionally seen; but necrotic foci in the liver are often found, as are nodules in the gizzard and catarrhal enteritis.

The lesions seen in adult carriers are similar to those seen in carrier chickens and are principally confined to the reproductive tract. In table 2 is given a summary of the results of bacteriological examination

TABLE 2

Results of Bacteriological Examination of Organs Removed From *Salmonella pullorum* Reactors

Organ	Number of organs examined	*Salmonella pullorum* isolated		Remarks
		Number	Per cent	
Ovary or testes	77	40	51.9	
Oviduct	66	31	46.9	
Umbilical yolk mass (yolk stalk)	37	26	70.3	
Abdominal exudate or caseated masses	14	7	50.0	
Reproductive organs, umbilical yolk masses, and abdominal lesions	77	72	93.5	The number of isolations here represent the number of birds found positive if only these organs were cultured.
Liver	52	16	30.8	Liver the only positive source in two birds.
Lungs	11	3	27.3	Lungs examined only if abnormal. Lung the only source in one bird.
Spleen	56	6	10.7	Spleen and liver the only positive source in one bird.
Intestines	45	5	11.2	
Bursa of Fabricius	21	4	19.0	Bursa the only positive source in one bird.
Kidneys	8	0	0.0	
Pancreas	9	1	11.2	
Eggs in oviduct	8	3	37.5	

of organs taken from reactors to the agglutination test. If only the reproductive organs, the unabsorbed yolk mass, and the caseated exudate found in the abdominal cavity had been cultured, 93.5 per cent of the positive diagnoses would have been made. *Salmonella pullorum* has also been isolated occasionally from the lungs, intestines, bursa of Fabricius, liver and, in one instance, testes of the reactors. A frequent finding in adults that have been killed in subacute outbreaks is a marked ascites. In these cases as much as 1,000 cubic centimeters of fluid containing yellowish caseated flaky masses may be removed from a single bird. As a rule such specimens yield *S. pullorum* from all tissues, including the intestines.

Egg Infection.—In the first edition of this bulletin (page 59) the writer reported the isolation of 5 cultures of *Salmonella pullorum* from 5 out of 945 eggs laid by 22 reactors. These eggs came from 4 birds. The reason for this low incidence is not understood because, since then, using the same technique, a much higher incidence has been found.

Prevention.—Now that pullorum disease has become widespread in turkey flocks, and turkey carriers are important means of transmission, all fowl carriers must be eliminated if the disease is to be prevented (fig. 30). The prerequisites in a prevention program are: (1) to establish a source of pullorum-disease-free eggs; (2) to have such eggs hatched in a hatchery that accepts eggs only from pullorum-disease-free flocks of turkeys, chickens, and other fowl, and (3) to brood and rear the poults in brooders with equipment that has had no contact with infected birds. If these three prerequisites are followed, together with a good management program, there is little danger that pullorum disease will become established.

In case an outbreak occurs, it is recommended that the survivors be marked and reared separately from broods that have not had the disease. Such groups of survivors should be sold for market and never kept as breeders. They should be marketed before they start to lay eggs. The remainder of the birds on the premises, if they are to be kept for breeders, should be tested by means of the tube agglutination test. According to Hinshaw and McNeil[84] this test, using a 1 to 25 dilution, made according to the procedure recommended in the National Poultry Improvement Plan,[85] is a reliable aid in locating pullorum-disease-free flocks, and in eradicating the disease from infected flocks. Hinshaw and co-workers[86] reported that the whole-blood, stained, antigen test was 50 per cent as efficient as the standard tube test for detecting carriers of pullorum disease.

The procedure to be recommended for eradication of the disease from infected ranches will depend on many factors, and every ranch has to be considered an individual problem when mapping out a program. Factors which have to be considered are: (1) type of manager; (2) plan of ranch; (3) type of available equipment; (4) size of yards; (5) drainage, and (6) history of flock. *In general the best recommendation, if infection is known to exist, is to sell the entire flock and replace it with stock from sources known to be free of the disease.* If only one age group

[84] Hinshaw, W. R., and E. McNeil. Eradication of pullorum disease from turkey flocks. U. S. Livestock Sanitary Assoc. Forty-fourth Annual Meeting Proc. (Chicago, Illinois, Dec. 4–6, 1940.) p. 178–94. 1940.

[85] The National Poultry Improvement Plan. U. S. Dept. Agr. Misc. Pub. 300: 1–28. 1941.

[86] Hinshaw, W. R., E. E. Jones, J. F. Harr, and W. E. Niemeyer. Comparison of the tube and whole blood tests for pullorum disease. Cornell Vet. 30(1):30–38. 1940.

is known to be infected, the sale of this group for market may suffice, provided the remainder of the flock is tested and found to be without reactors. The average percentage of reactors found in the initial test of a flock is not in itself sufficient information upon which to evaluate subsequent procedure.

Under no condition is any percentage of infection above zero to be tolerated if pullorum disease is to be eradicated from turkey flocks. Furthermore, hatcheries who accept any eggs (chicken, turkey, or other birds) from sources which are not known to be free of the disease, cannot be tolerated if eradication is to be accomplished.

It is possible to completely eradicate infection from a flock in one year; but, as stated above, many factors have to be considered. (See Hinshaw and McNeil, cited in footnote 84.) If an infected flock is to be used for production of hatching eggs, the following fundamental principles should be observed:

(1) Make the initial test when the flock is 4 to 5 months of age; (2) divide the flock into small groups on clean ground 2 weeks before testing; (3) remove all reactors promptly and dispose of them immediately; (4) thoroughly clean and disinfect all feeding and watering equipment; (5) dispose of all infected pens or remove them to clean ground as soon as reactors are removed; (6) retest infected pens once a month until free of reactors; (7) after all groups are free by the pen method, retest the entire flock in 1 month to ascertain if any new reactors have developed; (8) use eggs, for the breeding flock replacements, only from free-on-first-test sources; (9) have all eggs for replacements hatched by a hatchery accepting only eggs of like status; (10) practice a rigid sanitary program at all times. As stated above, the exact procedure will vary with the individual ranch setup.

It is often necessary to keep untested birds on the premises until they can be marketed; if complete segregation can be maintained, this may be done. Again, the individual ranch setup will influence the recommendations to be made.

It cannot be emphasized too often that the hatchery is the keynote of any eradication program. A single noncoöperating hatchery can destroy the results of an entire program by accepting eggs that are not equal in status to those from ranches coöperating in the program. Likewise, a noncoöperating grower can be responsible for spread of infection, by failing to observe the above recommendations. This is especially true in coöperative groups where pooled eggs from several ranches are often used for furnishing replacements to a single grower. In such organizations, the quality of the coöperative group's eggs is the quality of those of its poorest coöperator.

Bleeding the Flock for the Agglutination Test.—Since the breeding flock can usually be selected early in the fall and separated from the birds to be marketed, the turkey growers should do this before bleeding for the first test. At least 25 per cent more turkeys than are needed for the breeding flock should be separated to allow for losses caused by removal of the reactors and to permit culling for breed improvement. Males as well as females should be tested; and any chickens or other fowls kept in the vicinity should also be tested.

The first test should be made when the birds are from 4 to 5 months of age. This will allow ample time for at least two retests before they reach a production age—a plan which is essential if infection is found and the flock is to be kept for breeding purposes.

Much the same arrangement as was suggested for handling turkeys for fowl-pox vaccination may be used in corralling the flock (fig. 26). One should always consult the laboratory which is to do the testing for special procedures recommended by it. The type of vial used, the amount of blood desired, the type of shipping container, and the method of shipping the samples to the laboratory are factors which may vary. In case an official program is in operation it may be necessary to make special arrangements; and it is always a good idea to make application for a definite date several weeks before the testing is desired.

Two general methods are used for collecting the blood samples. One of these is by use of a hypodermic syringe and needle according to the method of Martin and Olney.[87] The second is by the so-called "stab" or "nick" method in which the wing vein is punctured with the aid of a sharp-pointed knife such as a Bard-Parker no. 11 (fig. 35). This is the most common method in use at the present time, but the method of Martin and Olney is increasing in popularity.

A procedure for collecting samples by the stab method follows:

1. Catch the bird, and identify it with either a wing band or a leg band. The type of wing band shown in figures 31 and 32 is a very good one for marking adult turkeys. It is an aluminum ear tag, commonly used for marking sheep, and is put on with special pliers (fig. 31), which clinch the band so that it is not readily lost. In official programs, where frequent inspection is necessary, leg bands are preferred, because they can be more easily seen by casual observation and without handling each bird. The heavy-duty type of leg band made expressly for turkeys should be used. Cheap bands are easily torn off, or rapidly wear out and are lost.

Bands should be purchased in consecutive numbers for as many birds

[87] Martin, H. M., and J. F. Olney. A more refined method for obtaining blood from fowls for serologic work. Amer. Vet. Med. Assoc. Jour. 70:652–55. 1927.

as are to be bled. It is a good plan to have the numbers for each succeeding year start with the series following that completed during the previous year. For instance, if 1–1,000 is used one year, 1,001–2,000 can

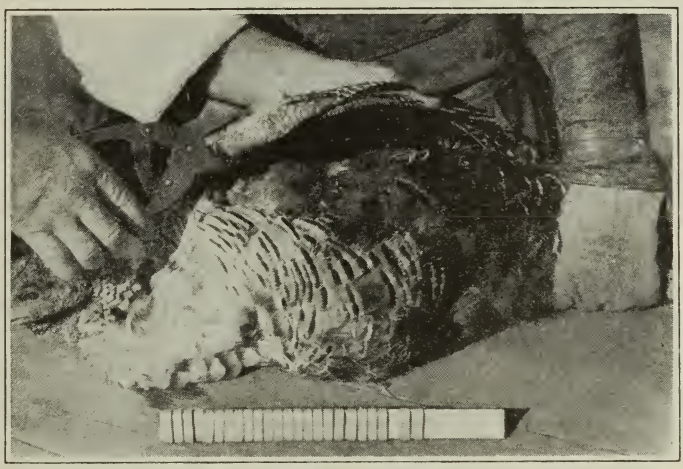

Fig. 31.—Method of wing-banding a turkey with sheep ear tags described in the text. See figure 32.

Fig. 32.—Close-up of the wing with a tag properly inserted.

be used the second year. Since breeders are seldom kept longer than two years, the series can start over for the third year. Such a system reduces to a minimum the danger of duplicating numbers.

2. Lay the turkey on the table (fig. 33) with the right wing folded under the body and the left wing exposed. With the right hand, the

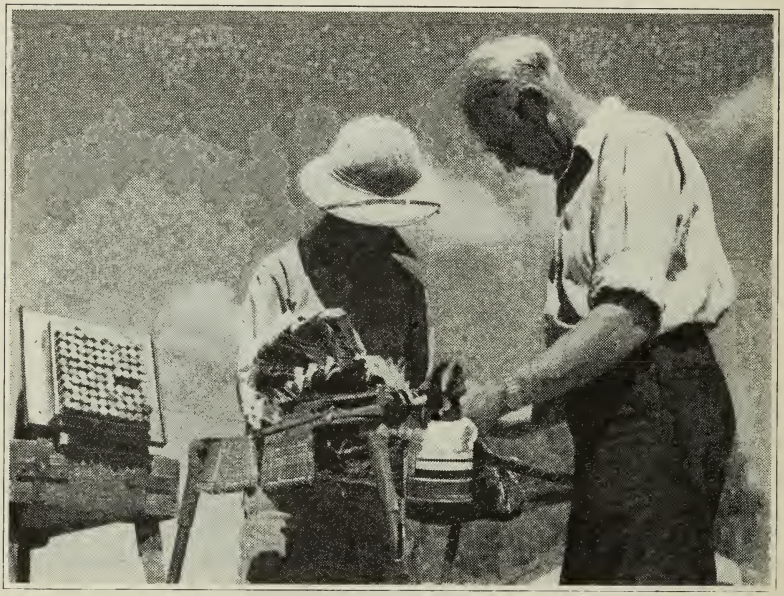

Fig. 33.—A suggested set-up for bleeding turkeys. The equipment consists of two "knock-down" portable tables. To one table is attached a rack for holding blood vials in a tilted position. The other, made of metal, with a wire top holds the bird, leg-band rack, and can for alcoholized cotton pad for cleaning the knife. In this system, one man punctures the vein, and the second man collects the blood sample. (See fig. 34.) (Courtesy of Ramona Turkey Growers' Association.)

Fig. 34.—*A*, Close-up of the wing with knife placed at the point of incision. *B*, Collecting blood in the vial, after making the incision.

legs of the bird should be held rigid and stretched out from the body. The left hand can then be used to extend the wing and expose the wing veins for the blood collector.

3. Pull out the feathers over the second joint from the body to expose the wing vein (fig. 34). The area may be brushed dry and clean with

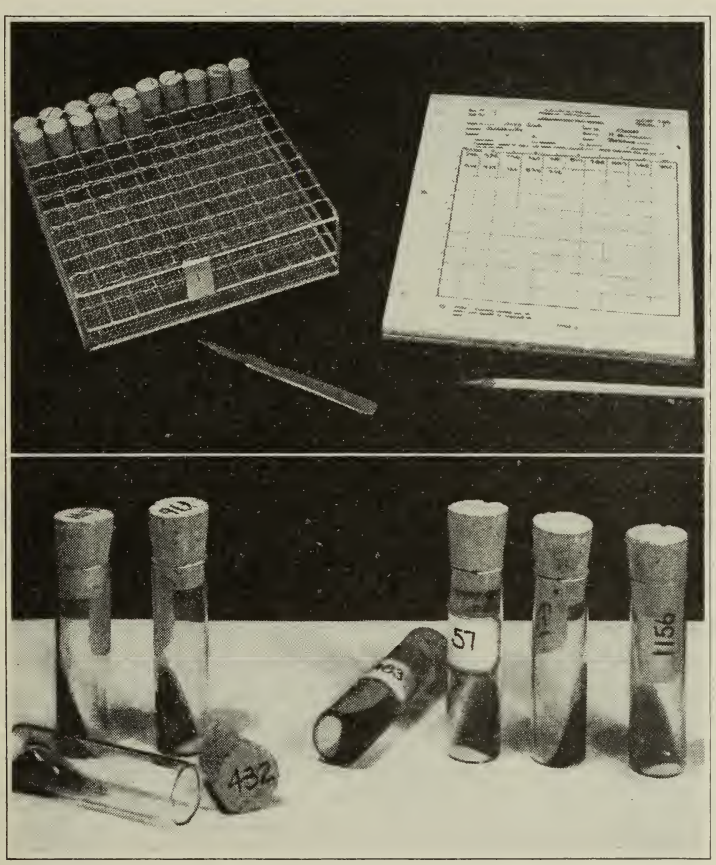

Fig. 35.—Equipment for bleeding turkeys. The upper picture shows a rack for holding blood vials, a bleeding knife, and a report sheet for recording numbers and other data pertaining to the flock. Below is a close-up of blood vials showing proper amount of blood, method of slanting the clot, and various methods of marking vials with band numbers.

a piece of cotton, but it is not necessary to disinfect it before bleeding, unless the skin is dirty. Swabbing the area with 70 per cent alcohol, allowing this to dry before bleeding, is then advisable.

4. Puncture the vein with a quick lengthwise movement of a sharp instrument like the knife illustrated in figures 34 and 35. *A deep or*

excessive slash type of incision crosswise of the vein is not necessary to obtain sufficient blood. A good sharp point on the knife which will insure a clean cut will insure plenty of blood without excessive bleeding.

5. Collect the blood immediately (fig. 34, *B*). A properly collected sample is one in which at least one-third of the bare area of the bottom of the vial is visible. One-half inch of blood properly slanted is ample (fig. 35). Cork the vial tightly, label it, or place it in the rack in the proper place and record the number accurately. Some laboratories use a system in which numbers on the vials are not necessary. The procedure recommended by the laboratory should then be followed.

6. Place the vials in a tilted position to allow the blood to clot on a slant (fig. 35).

7. If excessive bleeding occurs, place a small piece of absorbent cotton or a tuft of downy feathers over the wound before releasing the bird. Although turkeys bleed more easily than most chickens, they seldom bleed excessively. A few drops of 1 per cent solution of ferric chloride will aid in stopping hemorrhage. *Excessive bleeding is always an indication of poor technique on the part of the blood collector.*

8. Cool the blood in a refrigerator, or pack the samples in ice for shipment to the laboratory. If samples are to travel for any distance, two drops of a saturated solution of boric acid in sterile physiological saline in each vial will help to preserve the blood until it arrives. Pack the samples well for shipment; and send them to the laboratory by the quickest route available, as soon as possible after collection.[88]

Additional precautions to observe when collecting and shipping blood samples are as follows:

1. Use clean, sterile vials. Vials may be sterilized by placing in a hot oven (350° to 400° F) for 1 hour; corks should be thoroughly cleaned and dried.

2. Have the skin dry at the time of taking the sample.

3. After each sample is taken, thoroughly wipe the instrument used for piercing the vein. Rubbing alcohol may be used to disinfect the instrument between birds, but it should be dried by wiping on a clean rag or piece of cotton before proceeding to the next bird.

4. Do not place the blood samples in the sun. They must be kept cool to prevent spoilage.

5. Do not allow water or disinfectant to come into contact with the blood.

6. Avoid the use of disinfectants other than boric acid, for preserving the blood.

7. *Follow the instructions of the laboratory which is to make the tests.*

Control and Treatment.—There is no practical method of control or treatment once the disease has become established in a brood. Daily

[88] Information regarding the testing of turkeys in California can be secured by writing to California State Department of Agriculture, Division of Animal Industry, Sacramento, California.

cleaning, with removal of all sick and dead poults several times daily, will aid in preventing its spread. Increasing the heat in the brooder may be helpful in preventing excessive loss. Cleaning and disinfecting the water fountains and feed hoppers several times daily and the use of fresh, unmedicated water are also recommended. No specific remedy against the disease has been found.

Every precaution should be taken to prevent contact of an infected brood with other broods that are to be brought into the house after the outbreak is under way. The brood suffering from the disease should be kept in isolated quarters. Under no condition should equipment used for the infected brood be used for later hatches until it has been thoroughly cleaned and disinfected.

When the disease has run its course, the survivors should be toe-marked and raised separately from the other lots. *None of the survivors should be saved for breeding purposes.* They should be marketed as soon as they are in condition, and the breeders selected from groups that have not suffered from the disease. These breeders should be tested as described under prevention.

STAPHYLOCOCCOSIS

(Staphylococcal arthritis, synovitis)

Jungherr[89] described a disease characterized by arthritis. More recently Jungherr and Plastridge[90] reported this disease and similar ones in poultry under the name staphylococcosis, as caused by *Staphylococcus aureus* and *S. citreus.*

Madsen[91] has described a similar disease characterized by a synovitis without involvement of the articular joints. Madsen's disease is probably the same as that described by Jungherr. It is becoming more and more prevalent in many turkey-growing areas, and may affect 2 to 10 per cent of the flock, according to Madsen.

Symptoms vary with the acuteness of the disease. In the acute type, depression, decreased appetite, with watery sulfurlike droppings similar to those of blackhead are common symptoms. Death may occur within 48 hours.

In less acute cases, the birds rest on their hocks and show swollen joints, which are hot and painful to the touch (fig. 36). The feet may be swollen and typical of the condition commonly called gout (fig. 37). Upon pressure the swelling fluctuates, indicating the presence of fluid exudate. In chronic cases, lameness is the chief symptom.

[89] Jungherr, E. Staphylococcal arthritis in turkeys. Amer. Vet. Med. Assoc. Jour. 82:243–49. 1933.

[90] Jungherr, E., and W. N. Plastridge. Avian staphylococcosis. Amer. Vet. Med. Assoc. Jour. 98:27–32. 1941.

[91] Madsen, D. E. Synovitis of turkeys. Turkey World. 17(2):24. 1942.

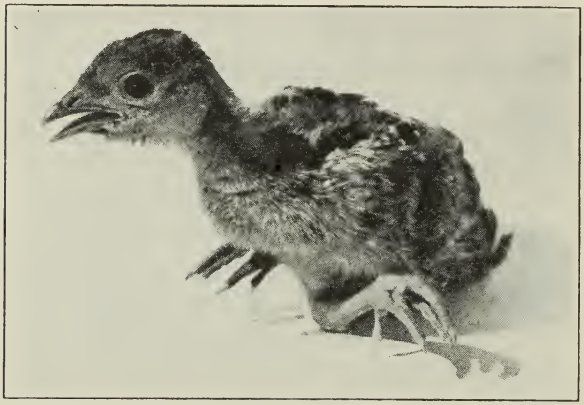

Fig. 36.—Staphylococcal arthritis in young poult.

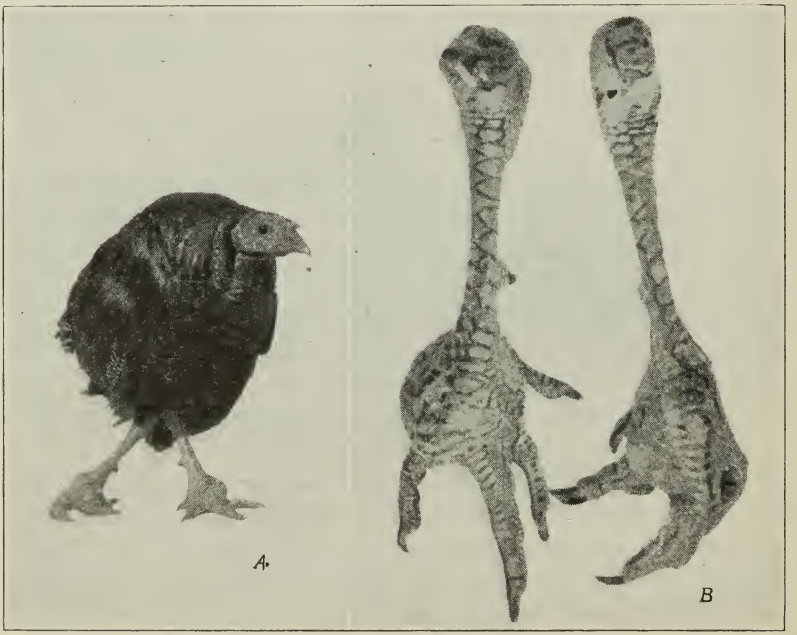

Fig. 37.—*A*, Staphylococcal arthritis in an adult turkey; note swollen joints of the feet. *B*, Close-up of the feet of the turkey shown in *A*.

Autopsy of acute cases reveals an enlarged and dark liver, with congestion of the mucous membranes of the intestines. The intestinal contents are watery and yellowish in color. Inflammation of the synovial membranes of the hock joints with increased fluid is characteristic. Chronic cases show principally an involvement of the joints and muscles

of the legs and feet. The exudate may vary from a semigelatinous to a cheeselike flaky consistency.

No remedy is known. Madsen tried sulfathiazole and sulfapyridine without success. Sulfanilamide and sulfathiazole in limited trials have been used at this station, also without results. The general recommendations for handling other infectious diseases are suggested.

STREPTOCOCCUS INFECTIONS

Generalized infections in turkeys caused by streptococci are being diagnosed with increasing frequency by poultry-disease diagnosticians. Volkmar,[92] reporting several outbreaks of apoplectiform septicemia in turkeys caused by a *Streptococcus*, described the disease as resembling fowl cholera. The losses are sporadic in nature, the disease is very acute, and symptoms are seldom seen before death. The principal lesions noted on autopsy are congestion or diffuse hemorrhages in the skin and breast muscles, together with a generalized congestion of the internal organs. Hemorrhagic enteritis and peritonitis are common, and the heart sac may be filled with a blood-tinged fluid. The disease must be differentiated by bacteriological studies.

Acute outbreaks of a disease in young poults with symptoms and autopsy findings resembling pullorum disease have been encountered at this station. Losses in these cases have equalled those of pullorum disease or paratyphoid infections. Examples of mortality experienced in these outbreaks are 430 out of 1,080 poults; 300 out of 1,200 poults; and 450 out of 1,500 poults. Losses in these outbreaks started within the first week and continued for 2 weeks. The symptoms seen were those of pullorum disease. The autopsy findings included congestion to necrosis of the lungs, congestion to necrosis of the liver, and enteritis. Pin-point areas of necrosis in the livers were especially common. A short-chain *Streptococcus* which has the characteristics of *Strep. zymogenes* has been consistently isolated from these cases. No detailed studies have been made of this disease, but mention is made of it since it may be confused with pullorum disease.

TUBERCULOSIS

Tuberculosis, a chronic disease affecting turkeys and other fowls, is caused by *Mycobacterium avium* Chester. It is not common in commercial turkey flocks, and all the outbreaks studied at this station have been associated with tuberculous chickens.

Symptoms.—There are no typical symptoms. Lameness and emaciation have occasionally been observed. Many turkeys that are found to

[92] Volkmar, F. Apoplectiform septicemia in turkeys. Poultry Sci. 11:297–300. 1932.

show lesions on autopsy maintain their weight for several months before death. Tuberculous turkeys placed in individual cages at this station and observed for periods of 1 to 10 weeks held their initial weight, and a few even gained. Such birds often go through intermittent periods of normality and depression lasting for 2 or 3 weeks before death. In the periods of depression, which last for 2 or 3 days, the feathers become ruffled, the appetite diminishes, and diarrhea develops. These periods are followed by a few days of normal appetite and general improvement of health.

Fig. 38.—Application of tuberculin test. The edge of the wing web proved to be the best site for the injection of tuberculin when testing turkeys for tuberculosis.

Clinical Diagnosis.—Tuberculosis in turkey flocks has, in the experience of the writer, been more often detected by accidental discovery of lesions during an autopsy by the owner, or by the housewife while preparing a bird for roasting, than by symptoms seen in the flock or by the use of the tuberculin test. Hinshaw, Niemann, and Busic[93] found that about 75 per cent efficiency can be expected from the use of the tuberculin test as a means of diagnosing tuberculosis in turkeys. The edge of the wing web (fig. 38) proved to be the best site for inoculation of the tuberculin; but the results, even in this area, were more difficult to interpret than in other animals.

Autopsy Findings.—The gross pathology of tuberculosis in turkeys has not been found to be markedly different from that of the disease in

[93] Hinshaw, W. R., K. W. Niemann, and W. H. Busic. Studies of tuberculosis of turkeys. Amer. Vet. Med. Assoc. Jour. 80:765–77. 1932.

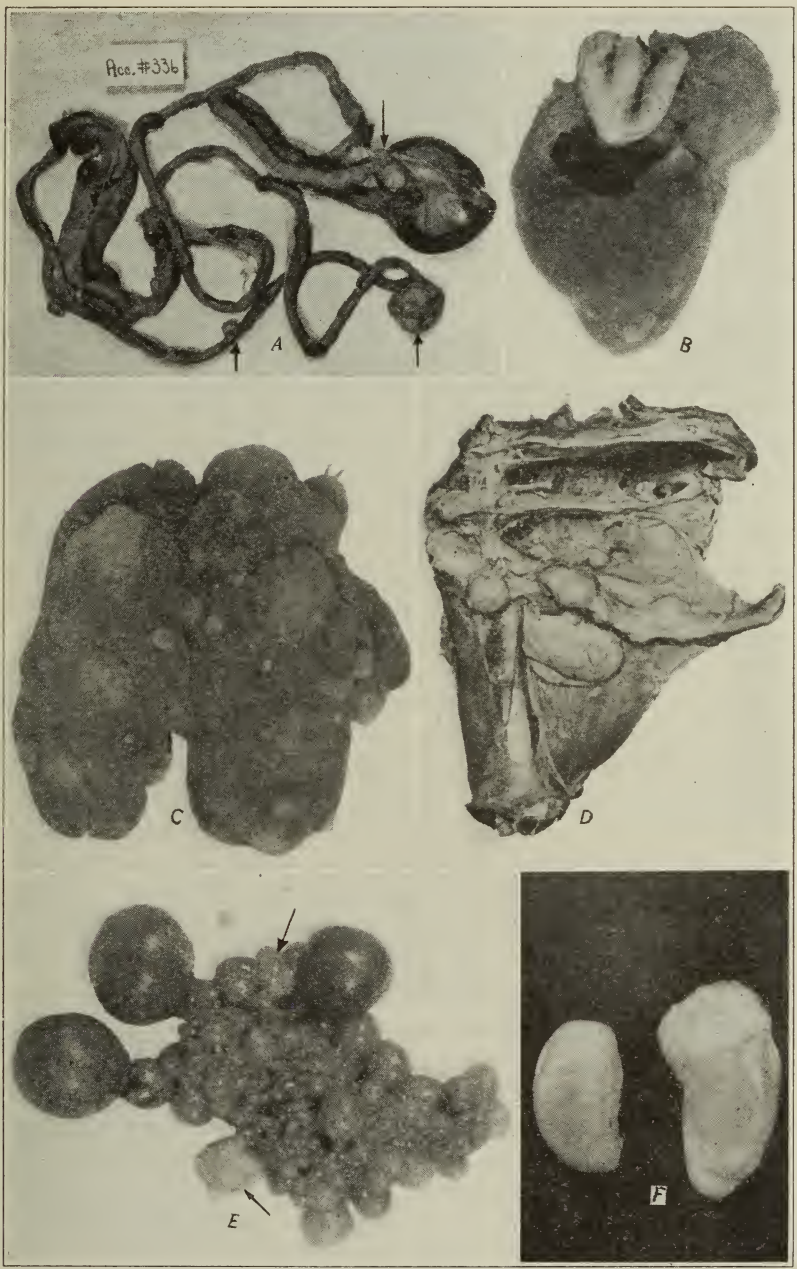

Fig. 39.—Tuberculosis lesions in various organs: *A*, intestines; *B*, heart; *C*, liver; *D*, abdominal and leg muscles; *E*, ovary—arrows point to the diseased ova; *F*, a diseased testicle (right), compared with the normal one from the same turkey.

chickens. The distribution of lesions in turkeys indicates a tendency for a greater number of organs to become infected than in chickens. Evidently, however, in turkeys as in chickens, the disease is principally abdominal in nature. Figure 39 shows typical examples of the lesions seen in various organs. Seven cases of tuberculosis in turkeys from five California outbreaks have been typed and found to be of avian origin.

A study of the distribution of lesions in turkeys from seven California outbreaks showed that the liver, bone marrow, spleen, intestines, ovaries, mesentery, skin, thymus gland, and lungs were, in the order given, the most common seats of lesions. The ovary and the thymus glands were more often found to be infected than in chickens. Attention is also called to the large percentage of cases of bone-marrow lesions. The number of birds examined for these lesions was small as compared with the total, but they were in all stages of the disease. When lesions were found in the bone marrow, they were always found in at least one other organ.

The high percentage of lesions in ovaries suggests the possibility of transmission through the egg. A limited number of eggs from tuberculous turkeys have been examined, however, without discovery of the tuberculosis organisms. The same eggs inoculated and fed to rabbits and turkeys also failed to produce tuberculosis in either species.

Differential Diagnosis.—Some of the conditions noted in turkeys which might be confused with tuberculosis are mycosis, blackhead, and tumors. Mycotic lesions in the liver and kidney, which on first glance are suggestive of tubercles, have been observed. These are not definitely capsulated and circumscribed, however; and on microscopic examination, mycelia are found, while acid-fast rods cannot be demonstrated.

Blackhead, or infectious enterohepatitis, should not be confused with tuberculosis, for the lesions in the liver do not resemble tubercles. Furthermore, the well-known characteristic lesions of the disease in the ceca should help to differentiate it from tuberculosis. On the other hand, tumors of the liver and ovary have been noted that were suggestive of tuberculosis until microscopic examination failed to reveal acid-fast rods.

Prevention, Control, and Treatment.—Complete isolation of turkeys from chickens will do much to prevent tuberculosis. Once the disease is found, it is a good plan to dispose of the entire flock, as well as all chickens on the premises. The best way to dispose of a tuberculous flock of turkeys or chickens is to sell them subject to condemnation. By such a scheme all birds showing lesions of tuberculosis on drawing are destroyed, and the owner is paid for the ones that are in a healthy condition.

Day-old poults, rather than adult stock, should then be purchased as

replacements. They should be brooded away from the infected area and should not be allowed to range there for at least one year after the diseased birds have been disposed of. A careful grower may sell the entire flock each year and start with day-old stock each spring for several years in order to insure freedom from tuberculosis. No treatment is known.

PROTOZOAN DISEASES[94]

BLACKHEAD

(Infectious enterohepatitis)

Blackhead, first described by Cushman[95] in 1893, is caused by a protozoan parasite, *Histomonas meleagridis.* No turkey disease has been more often described and discussed. It is given credit for being the cause of the temporary abandonment of the turkey industry in some sections of the eastern and midwestern United States. The early researches of Smith,[96] Moore,[97] Curtice,[98] Higgins,[99] Smith and Graybill,[100] and Tyzzer[101] paved the way for later studies which have proved that the disease is preventable.

Etiology.—Histomonas meleagridis, the causative agent, has an unusual life history, one which for many years baffled scientists. It is classified as a flagellate but is among the few that likewise have an ameboid stage. It is harbored by the common poultry cecum worm, *Heterakis gallinae,* found in the ceca, or blind pouches, of a large percentage of chickens. This, together with the fact that chickens are not, as a rule, highly susceptible to the parasite, has frequently been responsible for the transmission of the disease from apparently healthy chickens to turkeys.

The parasites are resistant and capable of living for long periods in the cecum worm and its egg. Van Es and Olney (cited in footnote 4, p. 3) found that the infection remained in vacant yards from the middle

[94] Written in coöperation with Ethel McNeil, Junior Animal Pathologist in the Experiment Station.

[95] Cushman, Samuel. Experiments with turkeys. Rhode Island Agr. Exp. Sta. Rept. for 1893:284–312. 1893.

[96] Smith, T. An infectious disease among turkeys caused by protozoa (infectious entero-hepatitis). U. S. Dept. Agr. Bureau Animal Industry Bul. 8:7–38. 1895.

[97] Moore, V. A. The direct transmission of infectious entero-hepatitis in turkeys. U. S. Dept. Agr. Bureau Animal Industry Cir. 5:1–8. 1896.

[98] Curtice, Cooper. The rearing and management of turkeys with especial reference to the blackhead disease. Rhode Island Agr. Exp. Sta. Bul. 123:1–64. 1907.

[99] Higgins, Chas. H. Entero-hepatitis or black-head in turkeys. Dominion of Canada Dept. Agr. Bul. 17:1–11. 1915.

[100] Smith, T., and H. W. Graybill. Blackhead in chickens and its experimental production by feeding embryonated eggs of *Heterakis papillosa.* Jour. Exper. Med. 32(2):143–52. 1920.

[101] Tyzzer, E. E. The flagellate character and the reclassification of the parasite producing "blackhead" in turkeys—*Histomonas* (Gen. Nov.) *meleagridis* (Smith) Jour. Parasitol. 6:124–31. 1920.

of November until the middle of June during each of five years when turkeys were reared in the yards from June to November. For a more detailed discussion of the parasite and a description of the organism, the reader is referred to the works of Tyzzer, of Delaplane,[102] and of DeVolt and Davis.[103]

Symptoms.—Blackhead, the common name for infectious entero-hepatitis, is a misnomer. Sometimes the head does become darkened, but this symptom is not characteristic of blackhead alone. Drowsiness, weakness, drooping wings and tail, lowered head, ruffled feathers, and a

Fig. 40.—Ceca of a turkey affected with blackhead. One cecum is swollen, with discolored diseased areas near the middle and at the tip. The other shows a single lesion near the middle. (From Cir. 291.)

constant sulfur-colored diarrhea are characteristic symptoms. As a rule, adult birds are sick for several days before dying and become very much emaciated. Young poults may have a very acute type of the disease and may die soon after symptoms are noted. Although turkeys of all ages are susceptible, the heaviest losses occur during the first 12 weeks of life. Another peak of mortality is often observed just after the birds are put on the finishing ration to prepare them for market. Sometimes a third peak of losses occurs during the breeding season, probably because of relapses from early infection.

The mortality is high, often approaching 100 per cent of the flock, and averages about 50 per cent unless kept under control. Once the

[102] Delaplane, J. P. Etiological studies of blackhead (entero-hepatitis) in turkeys. Rhode Island Agr. Exp. Sta. Bul. 233:1–15. 1932.

[103] DeVolt, H. M., and C. R. Davis. Blackhead (infectious entero-hepatitis) in turkeys, with notes on other intestinal protozoa. Maryland Agr. Exp. Sta. Bul. 392:493–567. 1936.

disease attacks a flock, occasional birds are liable to die between the intermittent periods of heavier losses, especially if the flock is not moved frequently to uncontaminated grounds. The period of incubation after contact with infection is 15 to 21 days.

Autopsy Findings.—The liver and the ceca are the principal organs showing marked changes caused by blackhead. The severity of these

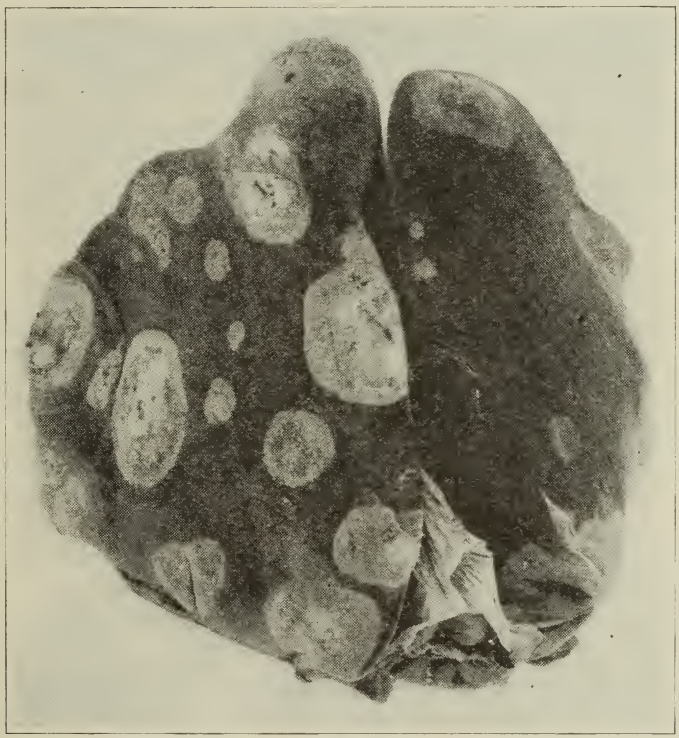

Fig. 41.—Liver of turkey affected with blackhead. (From Cir. 291.)

changes varies with individuals. The cecal lesions are apparently the primary ones, and one or both ceca may be affected (fig. 40). The lesions consist of marked inflammatory ulcers, sometimes involving most of the organ. A single ulcer may pierce the serous membrane and form an opening through the entire wall. The mucous lining often becomes necrotic, much thickened, and covered with a characteristic foul-smelling, yellowish-green, semicaseous exudate; or a dry, hard, cheesy core may fill the cecum.

The affected liver (fig. 41) presents a characteristic appearance, with areas of necrotic and degenerated tissues on the surface. These are more or less circular, have a yellowish to yellowish-green appearance, and,

in contrast to tumors and tubercles (tuberculosis), are somewhat depressed below the liver surface. They extend deeply into the tissue and are more or less confluent with the healthy tissue. In older birds the individual lesions are often merged. Evidence of healing is seen in the large amount of scar tissue in older birds. Occasionally peritonitis and involvement of the other organs may be observed.

Differential Diagnosis.—Blackhead must be differentiated from other diseases involving the liver and cecum. Chief among these are tuberculosis, tumors, and mycotic diseases. Allen[104] has described a disease of the liver which she claims is due to a species of *Trichomonas.* The lesions in this disease are easily differentiated from those of blackhead, as are the lesions of tuberculosis and mycotic infections of the liver. Demonstration of the causative agent by microscopic examination, together with culturing, must necessarily precede any attempt at a final diagnosis.

Treatment.—No drug or combination of drugs has been found that can be unqualifiedly recommended for stopping losses from blackhead once the disease has appeared in a flock. Nicotine products and phenothiazine, often falsely called blackhead remedies, have gained their reputation because of claimed successes in removal of cecum worms, which would aid in preventing the disease. Neither has been proved effective against *Histomonas meleagridis,* the causative agent of blackhead.

Mapharsen (meta-amino-para-hydroxy-phenylarsine hydrochloride), a drug containing 29 per cent of arsenic in trivalent form, has been reported by Blount,[105, 106] Bolin and Vardiman,[107] and McCulloch and Nicholson[108] as a promising remedy for treatment of blackhead. The trials reported by all these investigators concern small numbers of turkeys, and more data are necessary before the drug can be considered a specific remedy for this disease. The average dose for a 9-pound turkey given by Bolin and Vardiman was 6 milligrams of mapharsen dissolved in sterile distilled water (amount not given) and injected intramuscularly. McCulloch and Nicholson gave each of 27 sick turkeys, weighing from 8 to 12 pounds, 5 milligrams dissolved in 1 cubic centimeter of sterile water intramuscularly (pectoral muscles). According to them 17 (63 per cent) made complete recovery.

[104] Allen, Ena A. Macroscopic differentiation of lesions of histomoniasis and trichomoniasis in turkeys. Amer. Jour. of Vet. Res. 2(3):214–17. 1941.

[105] Blount, W. P. Clinical notes on poultry diseases. Vet. Jour. 94:278–82. 1938.

[106] Blount, W. P. New arsenical preparations in the treatment of blackhead in turkeys. Vet. Jour. 94:344–47. 1938.

[107] Bolin, F. M., and P. H. Vardiman. Mapharsen as a treatment for enterohepatitis of turkeys. Amer. Vet. Med. Assoc. Jour. 98:229–30. 1941.

[108] McCulloch, E. C., and L. G. Nicholson. Mapharsen therapy in enterohepatitis in turkeys. Vet. Med. 36:574–76. 1941.

Prevention.—Blackhead is a filth-borne disease dependent on carriers, including not only chickens and turkeys but probably other birds as well. These carriers void the causative organism in the feces, alone or with the cecum worm and its egg. When the organism is ingested by susceptible stock, the disease breaks out. As there is no practicable method of identifying carriers, all chickens and turkeys must be under suspicion.

The greatest need for prevention is during the most susceptible age, from hatching to 12 weeks. Van Es and Olney, in the bulletin previously cited, suggest the following methods:

1. Artificial incubation in order to escape the hazard arising from close association with the parent bird in the same environment.

2. Brooding in an enclosure from which all infection hazards have been previously excluded by attention to such details as hardware-cloth floor covering, and to all other measures by which actual contact with soil can be avoided.

3. Maintenance of the poults at least up to 12 weeks old, on clean ground not previously occupied by either turkeys or chickens.

4. Provision of a wide range for the maturing bird—if possible, one not previously occupied by blackhead-infected fowls. If such an environment is not available and the turkeys must be confined in more constantly occupied enclosures, yards should be covered either with coarse gravel or with 1-inch hardware cloth.

5. Maximum protection against the fecal contamination of food and water by the use of feeding and watering equipment especially designed for the purpose, as discussed under "Sanitation."

Billings[109] modifies this method of rearing turkeys free from blackhead. His plan is essentially the same as that of Van Es and Olney, being based on prevention by elimination, as far as possible, of the most important source of infection—namely, contamination of food and water with fecal matter from carriers. The principal difference in the two plans is in the substitution of a four-yard rearing system by Billings for the fourth step in the Van Es and Olney plan. The four-yard rearing system consists in dividing 1 acre into 4 yards. These are divided as suggested in figure 42. Three hundred poults can be raised in such a unit. The poults are reared for a month in each of the yards in succession. They are moved each month until marketed. The acre of ground can be fenced into the ¼-acre sections; or the fence may be a temporary one, set up around a different section each month.

Regardless of the system used in rearing turkeys, the following precautions against blackhead must also be observed:

1. Keep the turkeys entirely separated from the chickens or chicken yards. Drainage from chicken yards to turkey yards is a common source of blackhead.

[109] Billings, W. A. Talking turkey. Minnesota Agr. Ext. Bul. 124:1–28. 1928.

2. Do not rear turkeys on ground that has been fertilized with chicken or turkey manure.

3. Do not rear turkeys in yards where losses from blackhead have occurred until at least one year has passed after the removal of the last diseased bird.

4. Do not introduce new stock without quarantining it for 3 weeks before adding it to the flock.

5. Feed an adequate ration, with plenty of fresh, clean water.

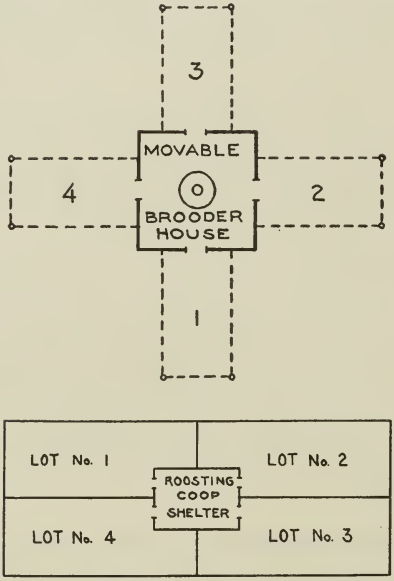

Fig. 42.—Two systems for rotation of runs suggested by Billings for prevention of blackhead.

The continual feeding of tobacco dust mixed with the mash as a preventive has been suggested by several experiment-station investigators. The principle of this plan is to prevent cecum worms from becoming established in the flock and thus to reduce the chances of transmission of the blackhead parasite by this means. Scott[110] recommends adding 4 pounds of tobacco dust, containing at least 2 per cent nicotine, to each 100 pounds of mash; this mixture is to be fed continuously from the time the poults are transferred from the brooders to the range. Recently McCulloch and Nicholson[111] and Nicholson and McCulloch[112] reported

[110] Scott, H. M. Kansas controls blackhead by feeding tobacco dust. Turkey World 10(5):10, 12, 48. 1935.

[111] McCulloch, E. C., and L. G. Nicholson. Phenothiazine for the removal of *Heterakis gallinae* from chickens. Vet. Med. 35:398–400. 1940.

[112] Nicholson, L. G., and E. McCulloch. New drug shows promise for controlling blackhead. Turkey World 16(5):12, 13, 48. 1941.

phenothiazine as an effective remedy against the cecum worm and suggest its use in prevention of blackhead. This drug is relatively nontoxic for chickens and turkeys and may prove of value as a preventive in areas or on ranches where the cecum worm is very prevalent and blackhead cannot be kept under control in any other way. The dosage recommended for turkey poults is ½ gram per poult and, for adults, 1 gram per bird.

Tobacco dust and phenothiazine are not remedies against blackhead itself and should not be used as such. Such remedial measures as just described are not recommended for general use where blackhead can be readily controlled by methods not involving drugs. Nor are these remedies recommended as general procedures if blackhead has not been proved to be a problem.

COCCIDIOSIS

Mortalities in young turkeys are often mistakenly ascribed to coccidiosis when some other disease is responsible. Most of the cases of bloody diarrhea, a common symptom of this disease in chickens, which are attributed to coccidia by turkey growers, feed salesmen, and others, are not caused by these parasites.

Only two species of turkey coccidia have been described: *Eimeria meleagridis* and *E. meleagrimitis*. Neither species is pathogenic for chickens, and none of the seven species of coccidia described for chickens has been definitely shown to be pathogenic for turkeys. For a complete description of these organisms the reader is referred to Tyzzer[113] and Becker.[114]

Symptoms and Mortality.—The symptoms of coccidiosis in turkeys differ considerably from those often seen in acute outbreaks of the disease in chicks. When trying to diagnose coccidiosis, therefore, one should not attempt to compare the symptoms of turkeys with those seen in chicks. The presence of the disease is strongly suggested by listlessness, drooping wings, ruffled feathers, and a light brownish diarrhea with considerable mucus.

Under good management and sanitary conditions, coccidiosis apparently does not cause severe mortality in turkeys. Although heavy losses have been associated with the disease, some contributing factor such as insanitary surroundings or inadequate diets has been observed in the outbreaks studied. Poults being reared by turkey hens have suffered more losses, in the experience at this station, than those being reared by artificial means, probably because the mother hen may continually eliminate large numbers of coccidia.

[113] Tyzzer, E. E. Coccidiosis in gallinaceous birds. Amer. Jour. Hyg. 10:269–383. 1929.

[114] Becker, E. R. Coccidia and coccidiosis of domesticated game and laboratory animals, and of man. 147 p. 25 fig. Collegiate Press, Inc., Ames, Iowa. 1934.

The following example illustrates how mortality from the disease can, without treatment, be reduced to a minimum by careful attention to sanitation. During the three years 1932, 1933, and 1934, 4,020 poults were hatched from the regular flock at the University Farm with a mortality to 30 weeks of age, from all causes, of 573, or 14.25 per cent. Although every poult that died during this period was subjected to a careful autopsy, coccidia were demonstrated in only 152. Of these, only 87 had infections severe enough to account for death. Thus the average mortality from coccidiosis for a three-year period was only 2.16 per cent.

Autopsy Findings.—Catarrhal enteritis, especially in the lower half of the intestine, is characteristic. In marked cases the intestine may be filled with whitish-gray semigelatinous pus containing myriads of coccidia. This exudate adheres to the intestinal wall and leaves a denuded area when scraped from the surface. Only by microscopic examination can coccidiosis be definitely diagnosed.

Transmission.—In the previous edition of this bulletin (pages 77–78) the results of studies to determine transmission of coccidiosis through the egg are recorded. These results showed definitely that coccidia are not transmitted in this manner.

A large percentage of the poults that survive an outbreak continue to be carriers and to shed the parasites in their droppings. Thus as long as adult turkeys are kept on the premises while poults are being brooded there is a continual source of infection. The means of transmission to poults in the brooder are many and include flies, tools, feed sacks, feed, and attendants.

Two types of experiments designed to demonstrate the possibility of the mechanical transmission of coccidiosis from the breeding flock to the poults have been completed at this station. One of these, conducted to determine how far coccidia can be carried by a person visiting an infected yard, proved by repeated trials that coccidia oöcysts can be carried as far as ½ mile on the soles of shoes and still remain capable of sporulating and producing disease. The second experiment was conducted to determine the possibility of transmitting coccidiosis by contaminated feed. Sterilized feed that was walked on, in the process of being mixed, by attendants who had previously visited infected yards, produced coccidiosis when fed to susceptible birds. Judging from the experiments on egg transmission and on mechanical transmission, coccidia are most likely to be carried mechanically from adult carriers to poults being brooded artificially.

Transmission to poults reared by turkey hens, however, is a different problem; obviously a group of poults brooded by a mother hen that

is eliminating coccidia will stand little chance of escaping infection. This fact explains why it is often more difficult to control coccidiosis in turkey-hen-reared poults than in brooder-reared stock.

Prevention, Control, and Treatment.—Prevention of coccidiosis in turkeys is best accomplished by preventing contact of the poults with the adult stock.

In artificial brooding, preventive measures are more practicable than when turkeys are brooded naturally; but two important avenues of infection exist—namely, the feed and the attendant. Indirectly, the attendant is a carrier of coccidia by way of feed, especially if he shovels it from one pile to another on a floor, since he cannot avoid walking on feed mixed in this manner. Visitors are also potential mechanical carriers.

Buying day-old poults from reliable hatcheries and using artificial brooding methods are to be recommended for the turkey grower who has a badly infected flock of adult turkeys. In such instances all adult stock should be disposed of several weeks before the poults are purchased, and the poults should be reared in houses and yards that have not been used for the adults. This procedure eliminates the most important source of infection, the adult turkey.

Coccidia oöcysts must have moisture in order to form spores, without which they cannot produce disease. Keeping thoroughly dry all areas to which poults have access will do much, therefore, to prevent acute outbreaks. Frequent changing of litter, the use of wire-screened platforms for water and feed containers, and ample floor space, are aids in keeping the floors of the brooder houses dry. The methods suggested for preventing blackhead will also aid in preventing coccidiosis.

Control of the disease in acute outbreaks may be accomplished by rigorous dry cleaning at daily intervals. Feeding a 40 per cent dried-milk mash may aid in the control program, but greater effort must be made to keep the floors dry while the milk treatment is used. A laboratory diagnosis must be obtained before this treatment is begun, because the treatment may cause severe losses in some types of enteritis not due to coccidiosis. It should continue only while justified by the response of the birds and should stop immediately if heavy losses are experienced. *The use of drugs is not recommended.*

HEXAMITIASIS

(Infectious catarrhal enteritis)

In the first edition of this bulletin (pages 80–82) is described a disease called intestinal trichomoniasis. After publication of the first edition, Hinshaw, McNeil, and Kofoid[115] discovered that a species of *Hexamita*

[115] Hinshaw, W. R., E. McNeil, and C. A. Kofoid. The presence and distribution of *Hexamita* sp. in turkeys in California. Amer. Vet. Med. Assoc. Jour. 93(3):160. 1938.

and not a *Trichomonas* was responsible for the disease. Furthermore, they learned in later studies[116] that the two species of *Trichomonas* commonly found in the ceca of turkeys and chickens were not capable of producing a similar disease.

The disease in question causes severe mortality in poults from 1 to 10 weeks of age and may, under unfavorable conditions, also cause losses in older poults. The causative agent has been named *Hexamita meleagridis* by McNeil, Hinshaw, and Kofoid.[117] They describe the parasite as follows:

This organism varies in length from 6 to 12μ (av. 9μ) and in width from 2 to 5μ (av. 3μ) without flagella. The nuclear membrane is distinct, and the karyosomes

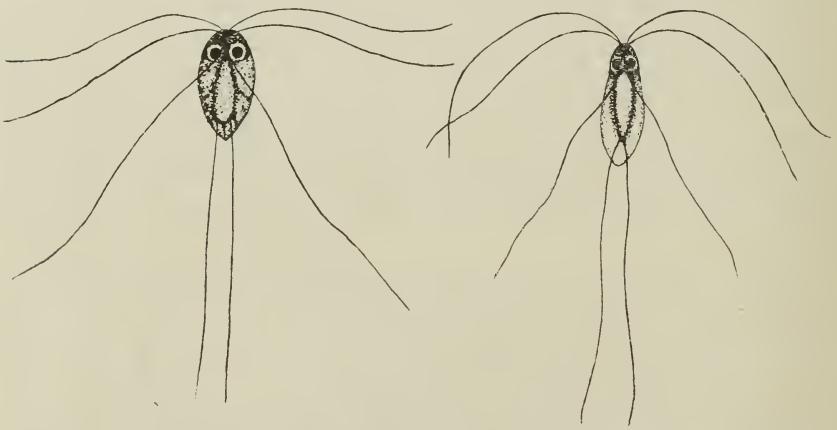

Fig. 43.—*Hexamita meleagridis* from the intestine of a turkey poult, showing individual variation in size and shape. (Greatly enlarged.)

are round and fairly large (two-thirds diameter of the nucleus). Anterior to the nuclei are 2 large blepharoplasts (or groups of blepharoplasts) from which arise the 4 anterior and 2 antero-lateral flagella. The flagella are all of about the same length, measured from the point of emergence from the body. The 4 anterior flagella are usually curved back along the body. Just posterior to these 2 large blepharoplasts are 2 others from which arise the 2 caudal flagella. These flagella pass posteriorly in a granular line of cytoplasm to their pockets of emergence near the posterior end of the body. (Fig. 43.)

Symptoms.—In the early stages of acute outbreaks the poults are nervous and require more heat than normally; the body temperature is normal or subnormal; the gait is stilted; the feathers are ruffled and unkempt. There is a foamy, watery diarrhea, but the cecal droppings do not appear changed.

[116] Hinshaw, W. R., E. McNeil, and C. A. Kofoid. The relationship of *Hexamita* sp. to an enteritis of turkey poults. Cornell Vet. 28(4):281–93. 1938.

[117] McNeil, E., W. R. Hinshaw, and C. A. Kofoid. *Hexamita meleagridis* sp. nov. from the turkey. Amer. Jour. Hyg. 34(Sec. C):71–82. 1941.

In most cases the poults continue to eat and may even appear to eat more feed because of a nervousness that is always evident. This nervousness is also manifested by the continual chirping of the birds, especially in the early stages. Owing to improper digestion and assimilation of feed, the poults lose weight rapidly. Many of the survivors continue to be underweight for weeks. In the later stages of the disease the poults become listless, sit under the hover, and finally go into a coma. Finally they struggle, flop their wings, and die.

Subacute attacks of the disease may occur in young poults early in the season before a typical build-up of the infection reaches the acute stage. Or one may see milder outbreaks in poults that reach a resistant age. In such outbreaks, listlessness and loss of weight are the most obvious symptoms. Loss of appetite will depend on the severity of the disease. Large numbers of stunted individuals result from this type of the disease.

Course and Mortality.—In experimentally produced outbreaks symptoms appear in 4 to 7 days after ingestion of the parasites. The period of incubation varies with the amount of inoculum and the age of the individual. If temperatures are taken daily following infection, a drop will often be noted a day before there are symptoms. Likewise, daily weight records will usually show a lowering of the normal daily gain before visible symptoms appear.

Mortality may start within a day after symptoms appear. In acute outbreaks the course of the disease is typical of an acute infectious disease with the peak of mortality occurring in 7 to 10 days following the appearance of symptoms. In most instances straggling losses occur for as long as 3 weeks; in a few, a second peak of mortality has been observed.

In outbreaks complicated with other infections such as salmonellosis or by upsets of managerial methods, the course may be varied and the mortality influenced. It is seldom that heavy losses occur in poults over 8 weeks of age unless there has been some lowering of resistance from another infection or from environmental factors. It is always desirable to eliminate the possibility of such complications whenever losses associated with the presence of *Hexamita meleagridis* are encountered in older turkeys.

Environmental and managerial factors, as well as age, greatly influence the mortality. It may vary from a few poults to the entire flock. Examples of heavy losses in large flocks are 4,000 out of 5,000, 6,000 out of 8,000, 6,000 out of 7,200, and 8,000 out of 10,000. Examples of mortality in experimentally produced outbreaks are as follows: For exposure at 4 days of age results were 80, 88, 72, and 100 per cent, for respective trials; for exposure at 11 to 13 days the percentages were

90 and 45; for exposure at 3 to 5 weeks of age the percentages were 7, 60, 40, and 25.

Under experimental conditions, using normal poults, the present writer has not been able to produce mortality in poults over 8 weeks of age.

Autopsy Findings.—At autopsy the birds are characteristically in poor condition; the feathers lack luster; the skin is dry; the flesh of the breast dry and reddened. In young poults suffering from an acute outbreak the crop usually contains some food; in poults that linger longer before death, it is usually empty.

The principal pathology occurs in the small intestine, where there is catarrhal inflammation with marked lack of tone. The contents may vary from a thick to a thin watery mucus; the thin mucus is most characteristic. Localized congested bulbous areas filled with watery contents are common.

The contents of the ceca may be more fluid than normal, but seldom changed. The only pathology noted in the ceca is a congestion of the cecal tonsils.

Diagnosis.—Diagnosis must be based on finding the causative parasite in the upper intestines. The examination of cecal or rectal contents is not recommended as a diagnostic procedure because of the necessity of having to differentiate other flagellates from *Hexamita meleagridis*. If smears are made from the duodenum or jejunum and diluted with physiological saline, this organism, if present, will be found free from other flagellates. It is necessary for best results to examine poults that have recently died; but the parasites have been found in refrigerated specimens even 48 hours after death. It may be necessary to warm the slide at 35° to 40° C for a few minutes, if the smears are taken from dead specimens.

The parasites may also be found in the bursa of Fabricius, and in the carrier stage they localize in this organ as well as in the cecal tonsils. When the acute disease subsides, the parasites can seldom be found in the upper intestines.

Transmission.—McNeil, Platt, and Hinshaw[118] found *Hexamita meleagridis* in California valley quail, in Gambel's quail, and in chukar partridges. Hinshaw and McNeil[119] in a survey of possible carriers found *Hexamita* in 16.5 per cent of 79 live adult turkeys by rectal examination and in 32.4 per cent of 74 turkeys by examination of scrapings from the cecal tonsil at necropsy. All of these birds were survivors of

[118] McNeil, E., E. D. Platt, and W. R. Hinshaw. *Hexamita* sp. from quail and from chukar partridges. Cornell Vet. 29:331–34. 1939.

[119] Hinshaw, W. R., and E. McNeil. Carriers of *Hexamita meleagridis*. Amer. Jour. Vet. Res. 2(5):453–58.

acute outbreaks. Also examined were 11 species of game and wild birds other than quail and chukars killed on or near infected ranches. None had *Hexamita.* Chickens, ducks, pigeons, and guinea fowl were negative for *Hex. meleagridis,* but pigeons were found to harbor *Hex. columbae* (McNeil and Hinshaw[120]). Ducks and chickens were artificially infected with *Hex. meleagridis,* but symptoms of the disease were not produced. Kimura[121] in a paper on *Cochlosoma* in ducks mentions the occurrence of *Hexamita* in the ceca and large intestine of domesticated ducks in California. McNeil and Hinshaw[122] found the parasite in chickens artificially infected 22 weeks after inoculation. A recent outbreak in pheasant chicks was (unpublished data) caused by a species indistinguishable from *Hex. meleagridis.* Thus the surviving turkeys, quail, chukars, chickens, pheasants, and ducks must be considered potential carriers of *Hex. meleagridis.*

No insect transmitter has been found. It has been possible to keep noninfected poults free from the disease when reared in proximity to infected brooders even though flies were abundant.

Epidemiology.—Management and environment play important roles in the transmission of this disease. The adult turkey that has survived an outbreak is the most important factor in perpetuation of the disease on a ranch. Chukar partridges, quail, and ducks may also play a part in starting an outbreak. Even though chickens have not been found infected under natural conditions, the fact that they may be artificially infected means that the parasite may sometime be adapted to them, and they must be considered potential carriers.

In the field the acute disease is usually seen in the later hatches, and often after the breeders have been marketed. Thus adult transmission is often difficult for the owner to understand, because his earlier groups did not show symptoms. The explanation based on experimental and field studies is that the early hatched poults act as a reservoir for increasing the dosage and probably the virulence of the parasites, and serve as the intermediary transmitter from the breeders to the later-hatched poults. Experimentally it takes from three to five passages of parasites removed from turkeys in the carrier stage through young poults before a build-up of infection is obtained to insure acute outbreaks.

Environmental and managerial factors play an important part also in getting the infection established in epidemic proportions. In most instances as the brooding season advances, the volume of work on the

[120] McNeil, E., and W. R. Hinshaw. The occurrence of *Hexamita* (*Octomitus*) *columbae* in pigeons in California. Jour. Parasitol. 27(2):185–87. 1941.

[121] Kimura, G. G. *Cochlosoma rostratum* sp. nov. an intestinal flagellate of domestic ducks. Amer. Micros. Soc. Trans. 53:102–15. 1934.

[122] McNeil, E., and W. R. Hinshaw. Experimental infection of chicks with *Hexamita meleagridis.* Cornell Vet. 31:345–50. 1941.

ranch increases and the space available per bird is less; this increases the chances for spread of disease. The difficulties arising with the hot weather or, in some areas, late spring fogs also contribute to the development of the disease in later broods.

Prevention, Control, and Treatment.—The primary source of infection is the intestinal contents of carriers. The entire prevention program must be built around the recognition of this fact. Finding a satisfactory method of preventing the transfer of droppings from carriers to young birds is the most efficient method of preventing the disease. *No general recommendation as to the best procedure to follow can be given because every ranch requires a separate solution of the problem of eliminating the danger of having carriers on the ranch.*

Factors which will aid in solving the individual problems are:

1. Separate units and caretakers for the breeding flock and the young poults.
2. Separate equipment for each age group.
3. Intelligent use of wire platforms for feed and water.
4. Intelligent use of cement yards and wire pens.
5. Feeding and watering equipment kept sanitary at all times, and arranged so that the attendant need not enter the pens.
6. If the poults have undergone an outbreak of pullorum disease or paratyphoid, avoidance of changes in brooding until they are 12 to 16 weeks of age.
7. Selling all breeding birds 2 weeks before any poults are hatched.

Getting an accurate diagnosis is the first essential in the advent of a suspected outbreak of this or any other disease. It is only possible to do this with the aid of laboratory facilities, including the use of a good microscope as well as the use of bacteriological technique. Live, sick birds are necessary for the accurate diagnosis of hexamitiasis, although *Hexamita* may be found by an experienced laboratorian as long as 48 hours after death of the poult, if too rapid decomposition has not taken place.

Complete isolation and quarantine of infected pens to prevent spread of the disease to normal poults is the most important factor in the control program. Remedies either in the drinking water or in feed should be avoided. *Keeping the poults warm by increasing the heat in the brooder house and increased effort to keep them comfortable are essential.* Removal, with destruction by burial or burning, of all dead poults several times a day, and daily dry cleaning of the houses and yards are essential to prevent undue spread of the infection. Efforts to prevent spread from sick pens to well pens will be much more profitable than time spent in mixing remedies or medicated mashes.

No treatment yet tried in controlled experiments has been effective.

Drugs and combinations of drugs that have been tried in experiments include mercuric chloride (1–8,000, and 1–4,000 as a substitute for drinking water), sodium bicarbonate (baking soda), copper sulfate, nicotine sulfate, iodine, sulfanilamide, sulfaguanidine, and several arsenical preparations. None gave any promise for either preventing or controlling the disease. A large number of patent remedies sold to turkey growers have also been tried under experimental and field conditions, and all have proved equally ineffective. Some of the drugs tried proved toxic for poults when given in dosages recommended. (See "Poisoning" for further information on mercuric chloride and sodium bicarbonate.)

Additional precautions for handling outbreaks of infectious diseases are given in the section "Handling an Outbreak of Disease."

TRICHOMONIASIS OF THE UPPER DIGESTIVE TRACT

(Necrotic ulceration of the crop, Jungherr's disease)[123]

Volkmar[124] has described a species of trichomonad which he calls *Trichomonas diversa,* associated with necrotic ulceration of the crop (Jungherr's disease). More recently Hawn[125] has shown that trichomonads are the causative agent in this disease. So far as is known, this species has not been found posterior to the proventriculus. Gierke[126] has described a necrotic ulceration of the upper digestive tract of chickens associated with a heavy infection of trichomonads similar to those described in turkeys by Volkmar and by Hawn.

Jungherr[127] in 1927 was the first to describe this disease. At that time he suggested that a fungus was the probable cause. It was three years later that Volkmar reported that *Trichomonas diversa* is a constant inhabitant of the crops of turkeys suffering from this disease; and, as mentioned above, Hawn has since shown these parasites to be the etiological agent. Stabler[128, 129] has shown the similarity of this trichomonad to the one in pigeons, which he points out should be known as *T. gallinae* instead of *T. columbae.* He suggests that the species in turkey be called by this name instead of *T. diversa.* The name *T. gallinae* must not be

[123] The name "Jungherr's disease" was first suggested by Beaudette in New Jersey Agr. Exp. Sta. Rept. 1930–1931:334.

[124] Volkmar, F. *Trichomonas diversa* and its association with a disease of turkeys. Jour. Parasitol. 17:85–89. 1930.

[125] Hawn, M. C. Trichmoniasis in turkeys. Jour. Infect. Dis 61:184–97. 1937.

[126] Gierke, A. F. Trichomoniasis of the upper digestive tract of chickens. California Dept. Agr. Mo. Bul. 22:205–08. 1933.

[127] Jungherr, E. Two interesting turkey diseases. Amer. Vet. Med. Assoc. Jour. 71:636–40. 1927.

[128] Stabler, R. M. The similarity between the flagellate of turkey trichomoniasis and *T. columbae* in the pigeon. Amer. Vet. Med. Assoc. Jour. 93:33–34. 1938.

[129] Stabler, R. M. *Trichomonas gallinae* (Rivolta, 1878) the correct name for the flagellate in the mouth, crop, and liver of the pigeon. Jour. Parasitol. 22:553–54. 1938.

confused, however, with *T. gallinarum,* a separate species inhabiting only the lower intestines of fowls. Levine, Boley, and Hester[130] have summarized the literature on this disease in birds and report further evidence that the species found in turkeys is the same as that found in chickens and pigeons. They were able to produce the typical disease in turkeys, chickens, bob-white quail, canaries, and English sparrows with a species isolated from chickens.

Fig. 44.—Posture typical in trichomoniasis of the crop. Note especially the sunken appearance of the crop area.

Epidemiology.—Most of the cases studied by the present writer have been in turkeys from 16 to 30 weeks of age, reared on range land. The following description of one outbreak in California is typical of the environment in which most of the cases are found:

The turkeys involved in this outbreak had been reared on the home ranch under semiconfinement methods until the middle of September, when they were driven daily to a cutover rice field about ½ mile from the ranch. Each day the birds were allowed to feed for 2 or 3 hours on the shattered rice left by the harvester. After this procedure had continued for about a month, the flock was permanently moved to the rice field and allowed to range at will. They were fed a mash supplement that was left near the roosts located on a dry area in a cutover barley field adjacent to the rice. Water was hauled from the home ranch; but the birds had access to the sluggish, algae-infested water in an irrigation ditch, which they had to cross in order to reach the rice from the roosting and mash-feeding areas. A seepage from the ditch had caused a large, muddy stagnant pool to form near the edge of the rice field; the turkeys drank a great deal of this water and picked up the rice in the mud at the edge of the pool. Several similar pools were found in other parts of the field. The disease started within 10 days after the birds were permanently located on the rice field.

[130] Levine, N. D., S. E. Boley, and H. R. Hester. Experimental transmission of *Trichomonas gallinae* from the chicken to other birds. Amer. Jour. Hyg. 33:23–32. 1941.

Stagnant pools of water in undrained areas of range lands, such as the one described above, are frequently associated with outbreaks of this disease in California.

Symptoms.—The symptoms are similar to those seen in many other diseases. Darkened heads with sunken sinuses and a generally haggard appearance are characteristic. The chest always has a depressed appearance, with the crop empty and drawn in towards the body. This typical attitude is seen in figure 44. Lack of appetite, drooling at the mouth, roughened unkempt feathers, and a normal or slightly subnormal temperature are also observed. Diarrhea does not, as a rule, accompany the disease. A foul odor is always present.

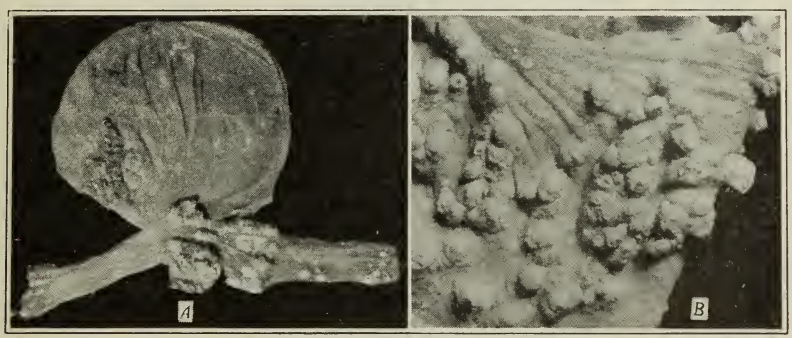

Fig. 45.—*A*, Necrotic ulceration of the esophagus and crop seen in trichomoniasis of these organs; *B*, close-up of typical pyramidlike necrotic ulcers characteristic of trichomoniasis of the upper digestive tract.

The course of the disease varies; but, as a rule, it is prolonged, and the birds become emaciated before death.

Autopsy Findings.—Chronic ulceration of the crop is the most common autopsy finding. The lower esophagus and, less often, the proventriculus and upper esophagus may also be involved. As a rule, the lower digestive tract and the other organs are normal. Aspergillosis of the lungs may be secondary to the necrotic ulceration of the upper digestive tract.

The lesions involve the glandular tissue and vary in size from a few to 15 millimeters in diameter at the base (figs. 45, 46). They taper to a point in concentric rings of necrotic tissue piled up to as much as 5 millimeters above the surface. They may extend into the tissue as much as 3 or 4 millimeters. The surface protruding into the lumen of the organ is rough, irregular, and surrounded at the base by a circular hemorrhagic ring. Those in the esophagus are usually smaller than those in the crop but are similar in shape and structure. When the proventriculus is involved, the esophageal portion is most affected. The lesions in the

proventriculus are usually coalesced and may appear to be a solid ring of necrotic material causing a marked thickening of the tissues and resulting in partial to complete occlusion of the lumen. In many such cases, impactions of the lower esophagus have been noted.

Prevention and Control.—Since the disease appears to be one directly associated with unsanitary surroundings, sanitation is of primary importance. In addition, adequate supplements must be fed to all turkeys being ranged on cutover grain fields.

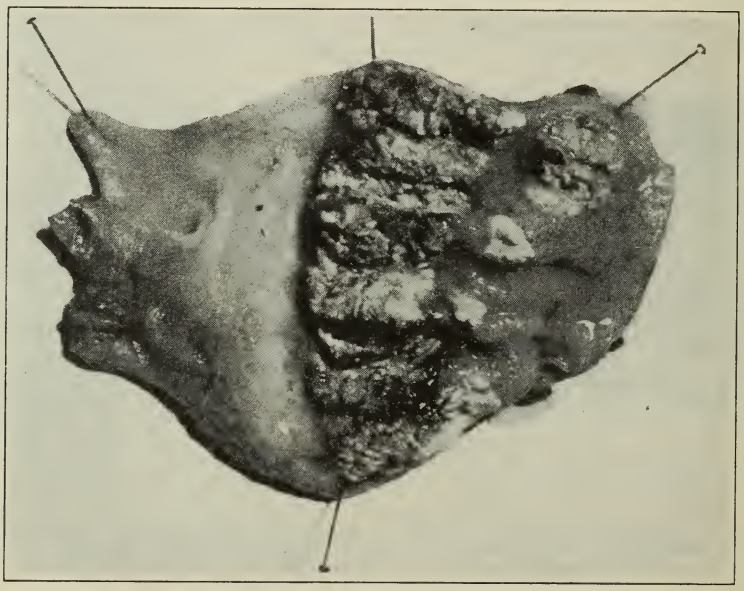

Fig. 46.—Necrotic ulceration of the proventriculus often seen in trichomoniasis of this organ.

The first requisite for control is also sanitation. As soon as the disease is observed, the flock should be moved to a dry, clean area and given plenty of pure, fresh water to drink. The feed should be checked to see that it is free from molds, and all access to old strawstacks, muddy trampled feed areas, and stagnant water prevented. Sick birds should be kept separate and cared for by a person who has no contact with the well birds. Removing the causative agent and giving the birds good care is more essential than treatment with drugs. The use of a 1–2,000 solution of copper sulfate (bluestone) in place of all drinking water is the only treatment tried by the writer that has met with any success. (See p. 19 for method of preparation.) If copper sulfate solution is used, it should be kept before the birds for 2 or 3 days and then repeated after a few days, if improvement has not been noted. All other sources of water should be removed during such treatment.

MISCELLANEOUS DISEASES

This section includes diseases and conditions which cause considerable financial loss in certain flocks but which are more or less sporadic in nature.

ABSCESS OF THE FOOT PADS
(Bumblefoot)

Turkeys sometimes suffer from abscesses of the foot pads (fig. 47). These may resemble corns and are similar to a condition, commonly called bumblefoot, in chickens. The cause is not known, but the abscess

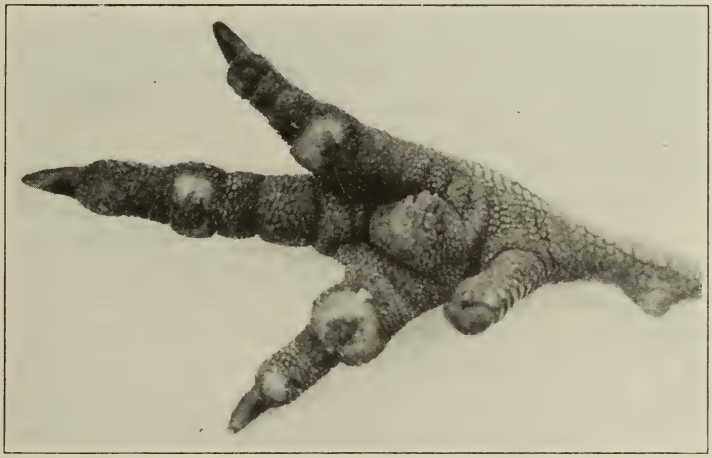

Fig. 47.—Abscesses of the foot pads (bumblefoot).

probably starts from an infection following an injury to the foot pad. Some of the cases observed by the writer have resembled foot rot as seen in other animals. In these instances the affected turkeys had been in yards that were in constant use and which were covered with several months' accumulation of feces; cases usually appeared after the fall rains, when the yards became very muddy. No doubt many cases of abscesses of the foot pads are also identical with staphylococcal arthritis.

Putting the birds in clean dry quarters and treating the diseased pad will cure many cases. If pus is present it should be removed, the area cleaned and treated with an antiseptic healing ointment or tincture of iodine. Ammoniated mercurial ointment is an example of a satisfactory ointment.

Rotating the runs and removing the birds to a clean well-drained yard just before the breeding season are recommended as preventive measures.

BLUEBACK AND CANNIBALISM

Blueback, as the name indicates, is a condition in which the backs of the affected turkeys are discolored blue or black. According to Billings,[131] it is caused by an injury to the quills of the feathers at the point of entrance into the skin which allows the pigment to escape, and tattoo the surrounding skin. Feather picking is the immediate cause, according to him. Some of the other causes are overcrowding in the brooder, keeping the poults too long on the sun porch, and lack of sufficient fiber in the ration. After picking becomes a habit, the vice is difficult to control, and the financial loss due to lowering of the market grade of the carcass may be considerable.

Preventive measures consist in avoiding overcrowding in the brooder; moving poults to the range as soon as picking starts; and reducing the numbers in a house. The feeding of whole oats is recommended by some as another means of prevention.

Another form of cannibalism which often results in evisceration may also be started by feather picking.

The use of mechanical devices for prevention of these vices is in common use, but there is not enough information available on controlled trials to warrant a recommendation of their general use. Two types are used: The first, inserted in the beak, is patterned after the hog nose ring, in use by swine raisers for prevention of "rooting." This is inserted in one side of the lower mandible (lower beak). A similar type, sold by one manufacturer, is pinned in the upper beak. The promoters of these nose-guard types claim that turkeys so fitted cannot pick feathers, so that the device prevents cannibalism. The second type consists of a metal or rubber guard which is pinned to the oil gland area so that the guard falls down over the vent and thereby protects the bird against cannibals. As stated above, more information on the value of these devices is needed before they can be generally recommended. When other methods fail, they may be worthy of a trial. Trimming the edges of the beaks will temporarily prevent picking.

Nestler[132] found that 2 per cent of salt in the mash fed to game birds for 4 or 5 days prevented feather picking. No definite information on the value of salt for prevention of blueback or vent picking is available, but the method deserves a trial.

Several ointments are on the market for use on injured birds, principally for prevention of further picking. These usually consist of a vaseline base, some bitter drug such as aloes, and a red coloring like

[131] Billings, W. A. Common diseases of turkeys. Minnesota Ext. Bul. 214:1–19. 1940.

[132] Nestler, R. B. Common salt as a curative for cannibalism among game birds in captivity. U. S. Bureau Biol. Surv. Wild Life Leaflet BS 163. (Mimeo.) 2 p. 1940.

carmine. Ewing[133] suggests an ointment made by mixing 4 ounces of vaseline, ¼ ounce of carmine, and ½ ounce of aloes. Roofing tar is also used by many growers.

ENTERITIS (NONSPECIFIC)
(Inflammation of the intestines)

Every year numerous immature turkeys die of enteritis from unknown causes. Further research, possibly, will prove some of these outbreaks to be infectious in nature. At present, however, they must be handled as nonspecific and can probably be attributed to a number of causes.

Stampeding, failure of brooder heaters, sudden changes in the weather, piling in the brooder houses, heat prostrations, sudden changes of feeding methods, and, probably in many cases, faulty feeding methods over a period of several weeks, are examples of obscure causes of mortality, with enteritis as the principal pathological manifestation. These various factors may also pave the way for secondary invasion by microörganisms normally of low virulence, which, under such conditions, may cause heavy mortality.

An example of losses starting from an obscure cause that may easily be overlooked follows: Three lots of turkeys about 12 weeks of age were in similar yards where it had been necessary to use an undesirable watering system until a modern drip system was installed. This new system was installed in all three yards at the same time, and the old system removed. Within 48 hours 2 of the 3 lots of turkeys became ill, while the third remained normal. On the third day it was discovered that the 2 groups of sick birds were not drinking the water because of an apparent fear of the new equipment. When the old equipment was replaced in these pens, the birds fought to get at the water and drank 3 or 4 times as much as normal for the day. Only 1 per cent of the birds died, but there was a distinct difference between the 2 affected lots and the third lot for nearly a month. A difficulty usually experienced in making a diagnosis for such outbreaks is the lack of sufficient history.

Losses are commonly experienced by turkey growers following the transfer of poults from the starting brooders to the "cooling" brooders. A common practice among some growers is to rear poults in small units such as the so-called "sunshine" type or in battery types for 3 to 4 weeks, and transfer from these to regular brooder houses with yards or wire porches. Losses following such transfers are usually due to failure to use the same type of feeders and waterers as in the starting brooders.

[133] Ewing, W. Ray. Handbook of poultry nutrition. 840 p. W. R. Ewing, Upper Montclair, N. J. 1940.

Use of similar equipment and careful watching of the poults to see that they start eating and drinking properly after such moves will stop these losses.

Symptoms.—The principal symptoms seen in enteritis are loss of appetite, a tendency to separate from the well birds, diarrhea, and a general haggard appearance. Temperatures are usually normal or subnormal. The birds may sit around in a listless manner with their heads hung, or turned up over their backs. On open ranges, where the majority of the flock is affected, difficulty is often experienced in keeping the birds under control; the turkeys appear nervous and may wander for hours, often straying ½ mile or more from the main camp. During the course of the disease, often a period of several weeks, a marked loss of flesh may occur. The mortality is not, as a rule, high for a single day; but over a period of 3 or 4 weeks, 25 per cent or more of the birds may die. The greatest loss, however, results from failure of the birds to recover completely and to make proper gains.

Autopsy Findings.—Emaciation and enteritis, varying from a catarrhal to an inflammatory type, are the principal autopsy findings. The head has a drawn appearance, with the eyes and sinuses sunken. The heart is usually flabby. The blood, in many instances, fails to clot for several hours after death; it is usually very dark in appearance. The liver often appears congested, and dark venous blood oozes from cuts made on its surface. In many respects the symptoms and autopsy findings resemble those of acute poisoning.

Prevention, Control, and Treatment.—It is extremely difficult to give methods of prevention, control, and treatment for enteritis of an unknown cause. Sound, rational turkey husbandry is probably the best preventive. An adequate diet and an ample supply of pure, fresh water are important.

Avoiding the possible causes of enteritis is essential. A few have already been mentioned, and others will suggest themselves. Any abnormality that will cause the bird to lose its appetite or develop an intestinal disturbance, even for a few days, may cause heavy losses for several weeks.

The successful feeder of any class of livestock realizes the need for constant attention to the flock or herd to detect the first symptoms of failure to make proper gains. Sudden changes of feed should be avoided; but, if the flock is definitely not doing well on a particular diet, the reason should be sought. If the feed is responsible, a gradual change to another method should be made. If the original method is resumed after the birds have recovered, the shift should also be gradual.

A common fault of turkey growers is to supplement an already ade-

quate commercial growing mash with milk, fish meal, or meat scraps, thus increasing a protein level already near the maximum tolerance for turkeys. If cheaper sources of high-protein feeds than are in a commercial product are available, the feed dealer should be consulted, and a properly balanced feed obtained to mix with the available supply. An equally common mistake and one that may cause very severe losses is to remove all mash supplement when turkeys are moved to barley, wheat, or rice ranges. The first month on a new range is probably the most important one, and no doubt more losses are experienced from failure of the birds to become properly adapted to the new environment than for any other reason. As the average grain field does not contain an adequate supply of all the necessary food elements for proper growth, a supplement is necessary.

The most important elements liable to be deficient on a cutover grain field are greens for vitamins A and G and protein concentrate. The amounts of each that are needed will depend on the amount of green grass and insect life available. Each range constitutes an individual problem and must be studied carefully; a suitable concentrate must be furnished the birds.[134]

Turkeys that are to be taken off a full-feed ration and transferred to a grain field should be fed some of the same type of grain as that grown in the field for a week or two before being moved to the range. This procedure accustoms them to the new grain and will prevent a setback and possible heavy losses. In addition, for a few days after they are moved to the range, the birds should have some of the mash previously used.

For control of enteritis, the methods suggested in the section "Handling a Disease Outbreak" are recommended. It is especially important that the cause be determined if possible, and eliminated.

ENTERITIS (Hemorrhagic)

Pomeroy and Fenstermacher[135] described a hemorrhagic enteritis in turkeys ranging from 7 to 12 weeks of age. The disease appeared in Minnesota during the summer months and caused a mortality of about 10 per cent. The flocks involved in this outbreak had been reared on wire porches for 6 to 8 weeks and were then transferred to field ranges. The losses occurred from 10 to 14 days after the poults were put on range. The ranges that year were very poor, greens were not available in sufficient quantities, and there was a distinct lack of shade and

[134] Information regarding formulas for concentrated mixes to be used as supplements can be secured by writing to Division of Poultry Husbandry, University of California, Davis, California. History of the previous feeding practices and information regarding the kind of feed available should accompany the request.

[135] Pomeroy, B. S., and R. Fenstermacher. Hemorrhagic enteritis in turkeys. Poultry Sci. 16:378–82. 1937.

shelter. *Escherichia coli* and an unidentified Gram-positive rod were the only bacteriological findings. Neither of these was proved to be the causative factor.

A similar condition to that reported by Pomeroy and Fenstermacher has been observed in a few instances by the writer. In these outbreaks the losses have always occurred a few days after the transferring of poults to ranges or to yards adjoining the brooder. In two such outbreaks the range contained a young succulent growth of alfalfa; and in a third the yard was overgrown with weeds and grasses, including some sweet clover. Losses stopped in all three when the poults were returned to the brooders and put back on a dry-mash ration. Later they were again on the range, at first for short intervals and finally for the full period, without further losses. The causative factor or factors were not determined.

These findings are additional reasons for use of great precaution when moving poults from one environment to another. See prevention, control, and treatment under "Enteritis (Nonspecific)."

HEAT PROSTRATION
(Heat stroke)

Heat prostration is usually associated with high humidity accompanying high temperatures or with very low humidity on excessively hot days. Losses from this cause most often occur in young turkeys that have recently been moved from the brooder house to a range having inadequate shade.

The symptoms are labored breathing, weakness, excessive thirst, and high temperature, followed by complete prostration.

Losses can be prevented by furnishing ample shade facilities, especially for the poults just transferred from the brooder house to an open yard or range. If a house is available on the range, the young poults may well be sheltered in it during the hottest part of the day, but with all the windows open for ample circulation of air. Plenty of water should be available. As soon as the poults become accustomed to the new quarters, they will stay inside during the excessive heat; water and feed should be left both inside and outside the house for the first few weeks. Out of doors, trees make the best shade; but an abundance of cheap artificial shade (fig. 48) can be made from old lumber and posts. Thatched roofs may be used advantageously if material for covering the shelter can be secured. Pure, fresh water must be available at all times. It should be kept in a shady place, in enough containers so that the birds will have no difficulty in getting to it.

If, in spite of all precautions, turkeys are overcome by the heat, they

should be put in a shady, well-protected place and sprayed with cold water. Used in time, this procedure will save a large number. Filling the crop with cold water by means of a rubber tubing and a funnel is also advisable. Dipping the birds in cold water may be effective, but care must be taken to prevent drowning. As they may remain weak for several days, they should be kept in the shade with food and water easily accessible.

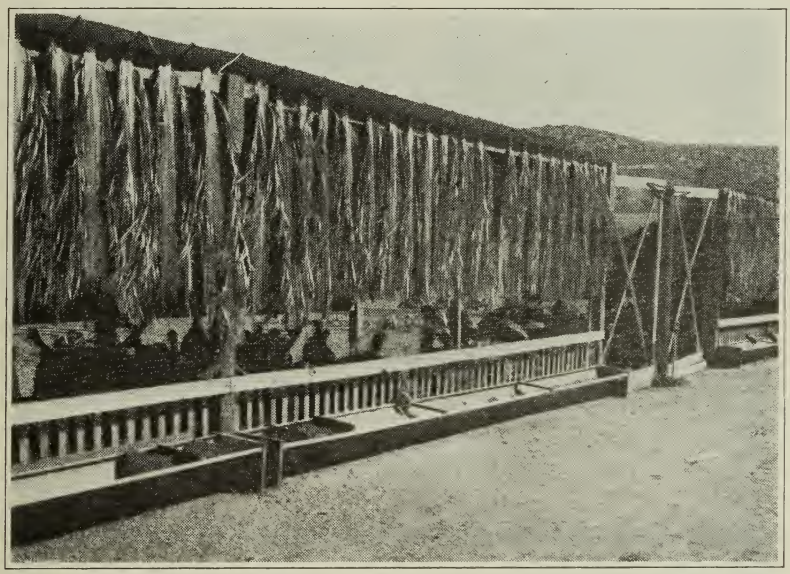

Fig. 48.—A cheap yet efficient form of shelter in use on one California ranch. Note the use of palm-tree branches on the south exposure.

INJURIES

Many types of injury cause losses in turkey flocks, and the value of an injured bird often warrants individual treatment. Some of the more common injuries are described below.

Injury of the Female by the Male.—Severe losses occur in many breeding flocks because of the female's being badly torn by the male during the mating process (fig. 49). Badly torn females seldom recover sufficiently to produce fertile eggs during the remainder of the season; and if the wound does heal, the area is tender and easily torn when the bird is trodden again.

Some males are much more vigorous and rough in the mating than others, and many of the losses can be traced to one or two individuals in a flock. These males should immediately be replaced by reserves. One method of prevention is the removal of the toenails from the males (fig.

50). This should be done about a week before the males are put into the breeding pens. A convenient instrument for removing the toenails is a pair of pruning shears of the roll-cut type shown in figure 50. An electric soldering iron or some other form of a searing iron can be used for

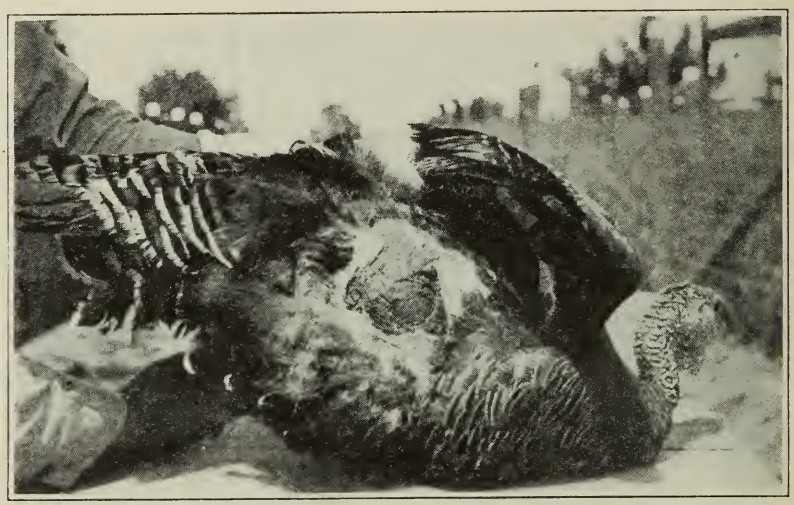

Fig. 49.—Turkey hen with a severe laceration caused by a male during the mating process.

Fig. 50.—*A*, Method of trimming the toenails of a male turkey to prevent injuries during the mating season; *B*, feet of a male turkey after trimming the toenails as illustrated in *A*.

searing the cut surface to stop hemorrhage after the operation. It is a good plan to smooth off the edges of the cut surface with a file or sandpaper just before the male is placed in the breeding pen.

Another method of preventing breeding females from being torn is to fit a canvas jacket over the back (figs. 51, 52). These jackets, which can be purchased at a reasonable price, are recommended for general

use. Care should be taken to purchase saddles which fit correctly, in order to prevent strangulation, or injury to the body or wings.

If an injured hen is discovered immediately, the torn edges of skin should be sutured with a heavy thread dipped in iodine. The bird should then be placed in a pen where there are no males and left for about 2 weeks. An antiseptic dusting powder such as boric acid, sodium perborate, or iodoform will induce healing and prevent attacks by flies. As soon as the wound begins to heal normally, the hen can be fitted with the canvas jacket described above and can be sent back to the breeding pen. She should be carefully watched, however, and if again injured by the males should be returned to the isolation pen.

Fig. 51.—A type of "apron" or "saddle" in common use for prevention of injuries to females during the mating season. See figure 52.

Wounds that are not discovered for several days respond poorly to treatment. They should be carefully cleaned and washed with a mild antiseptic solution and treated with an antiseptic dusting powder. It may be necessary to make an incision in the skin below the wound for drainage and to trim necrotic edges of the skin around the wound. The birds should be kept out of the breeding pens for 2 or 3 weeks and treated daily. They should be jacketed before being returned. Where several males are in one pen,

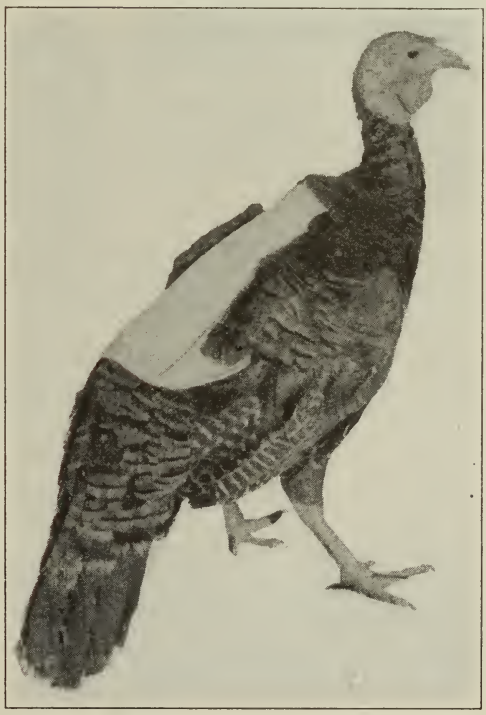

Fig. 52—Turkey hen with the "saddle" shown in figure 51 in place.

the transfer of a male to a pen of injured females may be a better procedure than putting the injured hens back in the regular pen. The time required for complete recovery depends on the extent of the injury and the efficiency of the treatment. Whether or not treatment is worth while depends on the value of the individual bird and the time available.

Injuries from Fighting.—As males are more liable to be injured from fighting than are females, often a valuable male should be separated from its penmates if it is getting the worst of a bargain. A male which has been away from the flock for any length of time or which has just been purchased must be protected when placed with other males, because they will invariably fight it.

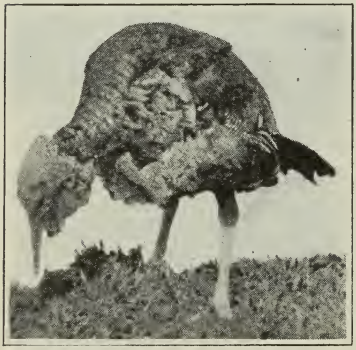

Fig. 53—Posture of turkey suffering from a slight dislocation of one vertebra of the neck. The bird could not raise its head, and the muscles of the area were severely swollen.

Minor injuries seldom require treatment and will heal readily if the bird is unmolested. Severe lacerations about the head usually respond to iodine or an antiseptic dusing powder. If flies are troublesome, carbolized vasoline can be used to cover the wounded areas.

Miscellaneous Injuries. — Injuries from being caught in fences, from flying into objects during stampedes, from rough handling, and from many other causes are cared for in much the same manner as injury by a male.

A type of injury seen a few times by the writer is shown in figure 53; the birds is usually found with its head hanging downward and forward and is unable to change this position. The neck muscles are much swollen and are hot to the touch. Often one will find a tuft of feathers pulled from the side of the neck and evidence of a bruise. Dislocation of a vertebra or fracture of a vertebral process has been found to be the difficulty in most cases. In at least two, the injury resulted from entanglement in a wire fence during attempts to reach feed. Correction of the dislocation by massage and tension gave relief and complete recovery in about 2 weeks. Other cases have taken from 3 to 6 weeks to recover but have shown no detrimental after-effects.

If such an injury is found in a flock, the cause should be determined. Any dislocation found should be corrected. A valuable bird should be taken to a veterinarian. Until recovered it should be isolated, but placed near water and feed containers.

OMPHALITIS

Omphalitis, or navel infection, is characterized by a failure of the navel opening (umbilicus) to close properly, with a resultant infection of the internal organs. The disease can usually be traced to faulty incubation or to unsanitary hatcheries. In most instances the poults are weak when removed from the incubator, and losses may start before time for shipment from the hatchery.

The symptoms are general weakness, lack of body tone, and a tendency to huddle. In the brooder the poults appear cold and stay under the hover. When handled they feel flabby, the abdomen is enlarged, and they do not have the firmness of a normal poult. The navel opening, which usually is completely healed in 72 hours, is inflamed and moist, and fails to close for several days. Often a definite scab forms over the opening. The course is rapid, death often occurring within a day after symptoms are noted; and the mortality is high, often 50 per cent.

On autopsy an edema of the muscles of the abdomen and breast, an unabsorbed yolk, and peritonitis are the principal observations. The contents of the retained yolk are usually more liquid than normal, and rupture of the yolk sac is common.

The disease is probably a result of a mixed infection of hatchery origin. In the outbreaks reported to the writer, a thorough cleaning and disinfection of the hatchery rooms and incubators has prevented further losses. The formaldehyde fumigation method outlined under the section "Disinfectants" will eliminate the disease from the hatchery. Bittenbender[136] suggests that twice the amounts of formalin and potassium permanganate be used to fumigate incubators known to be spreading omphalitis. *This strength should only be used between hatches.* Incubator rooms and all hatchery equipment as well as the incubators should be fumigated.

No remedy or adequate method of controlling the disease in the brooder has been found. Keeping the poults comfortable and applying hygienic measures will help reduce the mortality to a minimum.

PENDULOUS CROP[137, 138]

(Water crop, drop crop, baggy crop)

Serious losses from pendulous crop (fig. 54, *A*) in some flocks are, according to recent investigations at this station, apparently the result

[136] Bittenbender, H. A. Incubator fumigation. New England Poultryman 31(1): 8–9, July, 1940.

[137] Hinshaw, W. R., and V. S. Asmundson. Observations on pendulous crops in turkeys. Amer. Vet. Med. Assoc. Jour. 88:154–65. 1936.

[138] Asmundson, V. S., and W. R. Hinshaw. On the inheritance of pendulous crops in turkeys (*Meleagris gallopavo*). Poultry Sci. 17(4):276–85. 1938.

of a hereditary predisposition towards the condition. Turkeys with the inherent weakness develop pendulous crops after the increased liquid intake that follows the first wave of excessive hot weather. The crop, once expanded, seldom returns to normal size, especially if the hot, dry weather continues. It may contract for a few days, if the weather becomes cool, and then expand again during the next hot spell. Although a few birds recover, the majority continue to have pendulous crops. In this condition the crop does not empty normally; stagnant, sour liquid

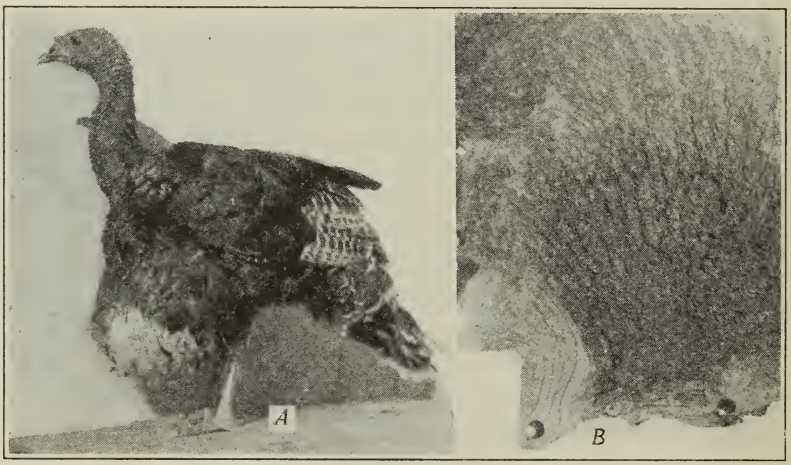

Fig. 54.—*A*, An 8-month-old female turkey with a pendulous crop of about 5 months' duration; *B*, section of a pendulous crop showing thickening and ulceration of the mucous membrane.

contents are retained in the bulbous portion. As time goes on, the mucous membrane thickens and may become ulcerated (fig. 54, *B*).

Although the appetite is not greatly affected, digestion is hindered. The feed and water remaining in the crop may increase until the crop and its contents equal one fourth of the total live weight of the bird. The bird may continue to grow, but will remain unthrifty and may become emaciated.

Pendulous crops caused by an inherent weakness must be distinguished from similar conditions that sporadically result from some different cause such as impactions, mycosis, trichomoniasis, and other crop infections.

Course, Mortality, and Causes of Death.—The course of the disease is chronic; as mentioned above, very few birds recover even with treatment. Some live for as long as two years, but the mortality of the affected birds in a flock may exceed 50 per cent.

The causes of death are: (1) rupture of the crop by the bird's toes in

its attempt to walk or run, (2) mechanical pneumonia from the seepage of crop contents into the bronchi during mechanical efforts to drain the crop or as a result of a back-flow when the bird lowers its head, and (3) starvation due to insufficient intake of food or to improper digestion.

Necrotic ulcers, varying in nature according to the type of the contents and the severity of the case, often occur. Scraping the necrotic membrane from the surface leaves a denuded, bleeding area. This type of necrosis is distinguished from that seen in trichomoniasis by the tendency of the latter to form individual pyramid ulcers as compared with the diffuse, spreading nature of the former. Demonstration of trichomonads furnishes a further means of differentiation. In a few cases, lesions typical of moniliasis (thrush) have also been observed. In these cases fungi are readily demonstrated. The contents of the crops have varied from a watery, sour-smelling mass to a solid bolus of mud, feces, and grain. Semiliquid contents have been most common. The contents usually suggest a depraved appetite.

Autopsy Findings.—Few or no changes in any organ except the crop and possibly the lower esophagus are seen on autopsy. The mucous membrane of the bulbous portion of the crop is thickened and in folds. Areas of diseased lung tissue varying in size are easily seen in those cases where the cause of death has been a mechanical pneumonia caused by the entrance of crop contents into the lung. In such cases food particles are found in the bronchi when the latter are carefully dissected. The air sacs are sometimes involved, and foreign matter can be seen when scrapings from them are examined microscopically.

Prevention, Control, and Treatment.—Since pendulous crops are associated with a hereditary weakness on the part of the individual, obviously the best preventive measure is to avoid mating any birds that have a family history of this weakness. Although this is a difficult procedure in the flock that is not trapnested, much can be done to prevent the condition from becoming established. Poults with affected crops should be caught and toe-marked or banded so that they can be eliminated at the time when turkeys are selected for breeding.

Sufficient shade during the hot months will probably reduce the number of pendulous crops in a flock. It is doubtful, however, whether any procedure other than eliminating the inherent tendency will remove the possibility of having a few cases.

Many methods for "curing" pendulous crops have been described by turkey growers. These have included various operations, the use of cloth vests or supporters, and methods of portioning out the water supply to the affected birds. Most of the methods that have come to the writer's attention, however, have produced few or no actual recoveries.

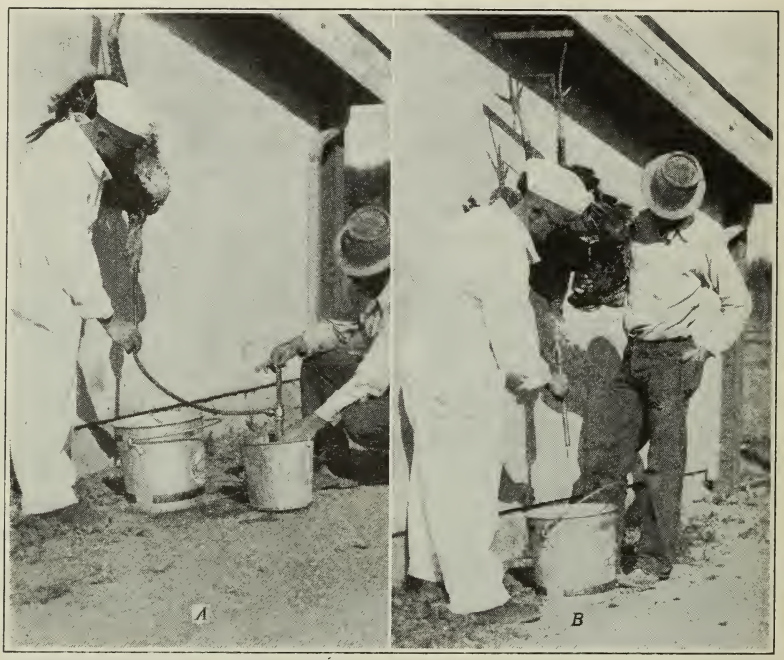

Fig. 55.—*A*, The use of a veterinary stomach pump for douching a pendulous crop; *B*, draining the pendulous crop which had been filled by the method shown in *A*.

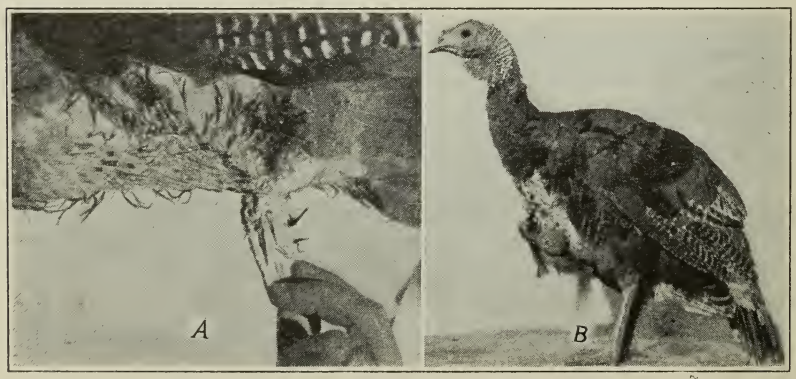

Fig. 56.—*A*, Method of tying off a section of skin to relieve pendulous crop. A suture is passed through the skin and then wound several times around before being passed through the skin a second time and tied. *B*, Turkey 3 weeks after being treated as indicated in *A*. Note that the tied-off section of skin has become necrotic and is about ready to drop off.

Removing a portion of the crop surgically results in a high percentage of recoveries, but the time consumed probably does not warrant the procedure as a routine practice. Washing out the crop (fig. 55) with warm

water containing a weak antiseptic, and then tying off a portion of the skin over the enlarged crop, also yields temporary relief until market time in a small percentage of cases (fig. 56). If only a few cases appear, it is probably more economical to kill the affected birds than to attempt treatment.

POISONING

Although losses from poisoning in turkey flocks are not great, a few cases are briefly described below. The tolerance of turkeys to rodent poisons is also discussed in answer to inquiries on this subject. In most outbreaks traced to poisoning, the symptoms and autopsy findings resemble those already described under the heading of enteritis. The diagnosis depends on discovering poison by chemical analysis of the crop or gizzard contents or on finding poison in the food supply.

Arsenic.—DeLay[139] reported losses in 10-week-old poults from eating grasshopper bait containing sodium arsenite and bran moistened with water. The bait had been spread unevenly on a turkey range so that the birds had access to clumps of the mixture as well as to the grasshoppers. The owner reported a mortality of 5 per cent from the poisoning. Some of the same mixture was eaten by 8-week-old poults in such a manner that the poults consumed from 0.25 to 0.5 gram of arsenic trioxide; both dosages resulted in death. The post-mortem findings in the field cases described by him were grasshoppers in the crop, hemorrhagic inflammation of the duodenum and jejunum, and a sweetish odor of the gizzard and intestinal contents. Arsenic was detected in the intestinal contents and in the grasshoppers found in the crop, by the Gutzeit method.

According to Whitehead[140] arsenic in bran used for grasshopper poisoning is not present in sufficient amounts to produce mortality in birds, if the mixture is spread evenly and thinly over the ground. Growers are cautioned, however, to be sure that these recommendations are followed if such a procedure is necessary on a turkey range.

Copper Sulfate (Bluestone).—According to experimental work by the writer and W. E. Lloyd,[141] turkeys may be poisoned by copper sulfate added to the drinking water in concentrations greater than 0.2 per cent (1–500 dilution). As turkeys do not like copper sulfate solutions in any dilution and will avoid them if untreated water is present, poisoning is unlikely unless no other source of drinking water is available. In cool

[139] DeLay, P. D. Grasshopper-poison bait and turkey mortality. Amer. Vet. Med. Assoc. Jour. 97:149–50. 1940.

[140] Whitehead, F. E. The effect of arsenic, as used in poisoning grasshoppers, upon birds. Oklahoma Agr. Exp. Sta. Bul. 218:1–54. 1934.

[141] Hinshaw, W. R., and W. E. Lloyd. Studies on the use of copper sulphate for turkeys. Poultry Sci. 10:392–93. 1931.

weather turkeys may go without drinking for several days rather than drink water containing even nontoxic doses of this chemical. For these reasons, copper sulfate is not recommended except for specific uses and in concentrations not exceeding 0.05 per cent (1–2,000 dilution). The poisoning is usually evidenced by a greenish-blue stain on the crop. Marked erosion of the mucous membranes follows excessive doses.

Mercuric Chloride (Corrosive Sublimate).—Mercuric chloride is well known for its toxic nature, but in spite of this is often carelessly used around turkey ranches as disinfectant and remedy. It is too commonly recommended for treatment of drinking water without experimental basis for the recommendation.

A series of trials made on the toxicity of this chemical for turkeys (unpublished data) showed that a 1–2,000 dilution as a sole source of drinking water was toxic: with 8-week-old poults, 5 out of 6 were killed in 2 weeks. One poult lived for 2 weeks under such treatment but was definitely undersized when killed. Eight-week-old poults tolerated 1–4,000 dilution for 2 weeks, but 1 poult out of 10 died in a 2-week-old group. Both groups given 1–4,000 dilutions failed to make normal gains. Both 2-week-old and 8-week-old poults tolerated 1–8,000 dilution for 2 weeks and made normal gains, but at autopsy the 2-week-old group showed some necrosis of the gizzard lining.

The principal autopsy finding in mercuric chloride poisoning is a marked thickening and necrosis of the gizzard lining. There was some escharotic thickening in the crop, and the mucous membrane of the proventriculus was often sloughed. The poults given 1–8,000 dilution (the amount usually used by growers) for an extended period (2 weeks) showed some thickening and necrosis of the gizzard membranes.

These results show the dangers encountered when using such toxic chemicals. Their use should be avoided.

Poisonous Weeds.—The fact that turkeys are often ranged among poisonous weeds suggests the reason for losses that are sometimes experienced on pasture lands. There are few experimental data available, however, on weed poisoning in turkeys. Where heavy losses occur in young turkeys reared on pasture, poisonous weeds should be sought as a possible cause. Suspected plants should be sent to a diagnostic laboratory for identification, along with specimens of diseased turkey for diagnosis.

As a rule, animals or birds will not eat poisonous plants unless other forms are not available. Most cases of poisoning result from the eating of young, growing shoots that come up in the spring before more palatable and nonpoisonous species appear. Under certain conditions the seeds of poisonous plants may cause losses if accidentally mixed with grains.

The only method of control is to remove the cause. If the birds are ranging in suspected areas, confining them in enclosures for a few days and supplying them with sufficient freshly cut greens is recommended. When they are again turned out on the range, the supply of fresh greens should be continued until the suspected poisonous plants have been replaced by nonpoisonous kinds.

Examples of poisonous weeds which have been known to cause losses in turkeys are the seeds of certain of the lupines, young shoots of oleander, the second succulent growth of Sudan grass, and whorled milkweed.

Oleander (*Nerium Oleander*) poisoning in turkeys is occasionally seen, but under normal feeding conditions poults will not eat even the young, succulent shoots. In one experimental trial by McNeil and Denny[142] with 4-week-old poults, 5 out of 6 were killed by inserting leaves of oleander sprouts into their crops. The same poults had refused to eat the leaves when given as greens. The poults died within 24 hours after the forced feeding, and at autopsy showed hemorrhagic enteritis. Three adult turkeys were fed young, succulent oleander shoots for 2 weeks in lieu of greens. The birds continually refused them even when they were cut up and mixed with the grain. The presence of oleander leaves in crop and gizzard, together with a history of the poults' eating the plant, is evidence of poisoning.

Whorled milkweed (*Asclepias mexicana*) poisoning in chickens has been reported by Campbell.[143] Stiles[144] has reported poisoning in turkey poults caused by eating a similar species of this weed, *A. galioides*. The present writer (unpublished data) has observed poisoning in young turkeys caused by *A. mexicana*, which is the common one found in California. Half-grown turkeys, force-fed this species, showed typical symptoms and died as a result of feeding; but the plants were not readily eaten if other feed was present. Stiles reported that one gram of plant tissue per 100 grams of turkey produced symptoms and death comparable with those seen under field conditions.

Symptoms are unsteady gait and muscular spasms with incoördination and nervousness. Experimentally produced symptoms resembled those of strychnine poisoning, but poisoned individuals do not respond to noises as in strychnine poisoning.

Autopsy findings are those of a toxemia. The finding of fragments of the plants in the crop and gizzard is evidence of poisoning.

[142] Unpublished data, used by permission.

[143] Campbell, H. W. The whorled milkweed as a poisonous plant for poultry. California Dept. Agr. Mo. Bul. 20(8):577–82. 1931.

[144] Stiles, G. W. Poisoning of turkey poults from milkweed (*Asclepias galioides*). Poultry Sci. 21(3):263–270. 1942.

If other green feed is available, turkeys do not relish whorled milkweed plants; and supplying adequate amounts of other green feed will reduce the chances of poisoning. Eradication of the weeds from the feeding areas is the best preventive procedure.

Sodium Bicarbonate (Baking Soda).—Sodium bicarbonate has been shown by several investigators (Delaplane,[145] Hoffman,[146] and Witter[147]) to cause losses in chickens. These losses are manifested by lesions in the kidneys and other organs similar to those seen in gout. Hoffman found that the continuous use of amounts of sodium bicarbonate in excess of 15 grams per gallon of drinking water is toxic for baby chicks if the solution is substituted for all other drinking water.

The toxicity of this chemical for turkey poults from 4 to 8 weeks of age has been determined at this station (unpublished data). The results obtained compared favorably to those reported by the above investigators. When more than 0.6 per cent of sodium bicarbonate was given in the drinking water to 4- and 6-week-old poults some mortality resulted, while 8-week-old poults were able to tolerate 1.2 per cent. Marked uremia and arthritis developed in all ages when over 0.6 per cent was given. As noted by Witter, sodium bicarbonate given in subtoxic doses also caused increased water consumption and diarrhea in turkey poults. Therefore, sodium bicarbonate is not a safe drug to use on the turkey ranch.

Sodium Chloride (Common Salt).—One outbreak of enteritis in turkeys about two thirds grown finally proved to be associated with the use of well water containing a high percentage of common salt. This was the only source of water, and the losses probably resulted from heat prostration combined with salt dehydration: the turkeys did not like the water and drank only small quantities. A supply of fresh water stopped the losses within a few days. Another instance of losses from enteritis probably due to salt eating was traced to boxes of salt placed on the range for sheep that were being pastured with the turkeys.

Strychnine.—Inquiries on possible poisoning by the strychnine-coated grain used for rodent control on cutover grain fields stimulated a series of experiments to determine the tolerance of turkeys for strychnine. To judge from the results, turkeys will tolerate the usual amounts of strychnine in poisoned grain. Despite considerable variation in individual tolerance, there is probably little danger provided other grain is available. Turkeys dislike grain coated with even minute amounts of

[145] Delaplane, C. F. Some of the tissue changes in poultry resulting from the ingestion of sodium bicarbonate. Ohio State Univ. Vet. Alumni Quart. 21:149–66. 1934.

[146] Hoffman, H. A. Unpublished data, used by permission.

[147] Witter, J. F. A preliminary report on the injurious effect of sodium bicarbonate in chicks. Poultry Sci. 15:256–59. 1936.

strychnine and, after the first taste, will usually leave the planted poison bait alone and hunt for more palatable food.

Miscellaneous.—Many other poisons could be mentioned; but they are not common causes of losses, and little is known on the exact tolerance of turkeys to them. Circumstantial evidence often points to poisoning when it is difficult to prove that a particular poison is responsible. Such chemicals as mercuric bichloride, lead arsenate, and thallium, used occasionally on the farm, should be stored out of reach of turkeys. While chemical sprays or dusts are being applied in orchards where turkeys are ranging, the birds should be removed. After the orchard has been sprayed or dusted, there is still some danger from the residue on the covercrop; and, if other range is available, the birds should be kept out of the orchard for several additional days, or until a rain has reduced the residue remaining on the forage.

TUMORS

Tumors of the ovary, and less often of other organs, have been a common cause of mortality in breeding turkeys on a few ranches. They have been more numerous in two- and three-year-old turkey hens than among the hens kept for only one year. The cause is unknown. The problem is not serious as yet, but turkey growers are cautioned against using breeding stock that has a tendency towards a high tumor incidence.

WORM INFESTATIONS[148]

CAPILLARIA WORMS

Of the several species of the genus *Capillaria* that infest domestic birds, at least three have been reported in turkeys. Two of these, *C. annulata* and *C. contorta*, infest the upper digestive tract, while one, *C. columbae* (Graybill,[149] Wehr[150]), is found in the intestines. Cram[151] reported *C. annulata* in turkeys in 1926 and later[152] published a comprehensive review on this and other species, giving the principal morphological characteristics of each. Emmel[153] has described symptoms, and

[148] This section and the following one on "External Parasites" have been prepared in coöperation with Morris A. Stewart, Associate Professor of Entomology and Associate Entomologist in the Experiment Station.

[149] Graybill, H. W. *Capillaria columbae* (Rud.) from the chicken and turkey. Jour. Parasit. 10:205–07. 1924.

[150] Wehr, E. E. Studies on the development of the pigeon capillarid, *Capillaria columbae*. U. S. Dept. Agr. Tech. Bul. 679:1–20. 1939.

[151] Cram, E. B. A parasitic disease of the esophagus of turkeys. No. Amer. Vet. 7(10):46–48. 1926.

[152] Cram, E. B. Species of *Capillaria* parasitic in the upper digestive tract of birds. U. S. Dept. Agr. Tech. Bul. 516:1–28. 1936.

[153] Emmel, M. W. Observations on *Capillaria contorta* in turkeys. Amer. Vet. Med. Assoc. Jour. 94:612–24. 1939.

autopsy findings observed in three outbreaks due to *C. contorta*. He calls attention to the penguinlike attitude of infested turkeys.

Prevention is the same as outlined for other parasites. Carbon tetrachloride has been found to be fairly satisfactory against the intestinal forms. The dosage is 1 cubic centimeter per bird, given orally and repeated in about 7 days.

CECUM WORMS

Cecum worms (*Heterakis gallinae*) are of economic importance because of their relation to blackhead. Widely distributed in chicken-growing areas, they serve as carriers of the blackhead parasite in both turkeys and chickens. These tiny parasites, ½ to 1 inch in length, are found in the ceca. Prevention and control are described under "Blackhead." Treatment is difficult because of the sheltered position of the worms within the ceca. Large doses (2 to 4 per cent) of finely pulverized tobacco dust in the mash have been known to remove them. The use of tobacco dust in the ration over a long period as a preventive measure is usually of doubtful value. If turkeys are reared according to the methods recommended, little trouble with cecum worms will be experienced.

FLUKES

Riley and Kernkamp,[154] Riley,[155] and Marotel[156] have reported a monostome fluke, *Collyriclum faba,* which encysts in the skin of turkeys and other birds. These usually are found in the abdominal region, and especially in the perianal region, with occasional cysts on other parts of the body (fig. 57). This fluke has been reported in many species of birds by other investigators. Although the complete life history has not been determined, Riley believes that snails probably act as the first intermediate host, and nymphs of dragon flies as the second intermediate host. English sparrows appear to be important disseminators of the parasites.

Annereaux[157] reported the occurrence of a typhlitis in poults caused by a fluke, *Echinoparyphium recurvatum* (von Linstow). The 10-week-old poults involved in this outbreak were being ranged along a creek where two types of snails and many tadpoles were present. The lesions found in the ceca of the affected poults were characteristic of those seen in the ceca of poults suffering from blackhead, but no liver lesions were

[154] Riley, Wm. A., and H. C. H. Kernkamp. Flukes of genus *Collyriclum* as parasites of turkeys and chickens. Amer. Vet. Med. Assoc. Jour. 64(5):591–99. 1924.

[155] Riley, Wm. A. *Collyriclum faba* as a parasite of poultry. Poultry Sci. 10(4): 204–07. 1931.

[156] Marotel, G. Une nouvelle maladie parasitaire, la monostomidose cutanée du dindon. Rev. Veterinaire 78(12):725–36. 1926.

[157] Annereaux, R. F. A note on *Echinoparyphium recurvatum* (von Linstow) parasitic in California turkeys. Amer. Vet. Med. Assoc. Jour. 96:62–64. 1940.

noted. Foggie[158] has reported an outbreak of parasitic necrosis of intestines of turkey poults in Ireland caused by a fluke *Plagiorchis laricola* (Skrjabin), normally a parasite of terns and gulls.

According to Macy,[159] the most important species of trematode parasites for North American poultry is *Prosthogonimus macrorchis.* Although it was not found in natural outbreaks, Macy could infest turkeys with this parasite; and typical lesions were observed in the oviducts

Fig. 57.—Cysts of the fluke *Collyriclum faba* on the skin of a turkey. (Courtesy of W. A. Riley and H. C. H. Kernkamp.)

of the parasitized birds. Few external symptoms of disease were noted, but in chickens it clogs the windpipe and causes the birds to gasp for trematode is transmitted by dragon fly nymphs (Lakela[160]).

No satisfactory treatment has been reported for trematodes in turkeys. Prevention of infestation consists in preventing access to marshy pastures, lake shores, or infested streams.

[158] Foggie, A. An outbreak of parasitic necrosis in turkeys caused by *Plagiorchis laricola* (Skrjabin). Jour. Helminthol. 15(1)35–36. 1937.

[159] Macy, R. W. Disease in turkeys due to *Prosthogonimus macrorchis.* Amer. Vet. Med. Assoc. Jour. 94:537–38. 1939.

[160] Lakela, Olga. Chickens definite hosts to species of *Prosthogonimus.* Poultry Sci. 11(3):181–84. 1932.

GAPEWORMS

The gapeworm (*Syngamus trachea*) does little damage in turkeys; but in chickens it clogs the windpipe and causes the birds to gasp for air—hence the name. The worm is a reddish color. The female may be 1 inch long; the male seldom more than ¼ inch. Usually the female clings to the lining of the windpipe with the male attached to her in copulation in the form of the letter *Y*. The eggs pass up the windpipe with the mucus, are swallowed, and pass from the body with the droppings. After a week to a month in the open air (according to the temperature), a fully developed embryo capable of infesting a healthy bird is formed. It may be ingested by the bird in the egg stage or as a free-living worm. There is evidence that eggs and free-living embryos may survive for some time in the alimentary canal of the earthworm, and thus be protected when they might otherwise perish from drying or from other unfavorable ecological conditions. The young gapeworm, taken by the bird as a developed egg or free-living larva, or in the body of an earthworm, penetrates the walls of the alimentary canal, is carried to the lungs, and works its way up the windpipe, where it attaches itself and sucks blood.

Mature turkeys may carry the infestation through life without showing symptoms. Wehr[161] found that survivors may carry the parasite for as long as 224 days. Such survivors are important means of transmission to susceptible chickens and turkeys.

Prevention consists in rearing turkeys on sandy, well-drained soil where earthworms are scarce and where the chances are good that the larval gapeworms will perish by drying. Wehr[162] suggests the following treatment as being the most effective of any tried by him. Approximately 1 ounce of barium antimonyl tartrate to 8 cubic feet is dusted in a fairly tight room or treating chamber, and the infested birds exposed to the dust for 15 to 20 minutes. The use of mechanical removers is not to be recommended because of possible injury to the patient.

ROUNDWORMS

The roundworm (*Ascaridia galli*), a common intestinal parasite of chickens, has no economic importance for the turkey industry in California. In the few cases encountered roundworms have usually not been the primary cause of the diseased condition in the flock, since only a few of them were found on autopsy.

[161] Wehr, E. E. The gapeworm as a menace to poultry production. Seventh World's Poultry Congress Proc. (Cleveland, Ohio. July 28 to Aug. 7, 1939.) p. 267–70. 1939.

[162] Wehr, E. E. Controlling gapeworms in poultry. U. S. Dept. Agr. Leaflet 207:1–6. 1941.

According to Ackert and Eisenbrandt,[163] turkeys are more resistant than chickens to infestation with the common roundworm. Turkey growers are therefore warned against treating their flocks for this parasite. At present, at least, the spending of money for roundworm remedies is wasteful; the sanitary procedures for preventing blackhead, fowl typhoid, coccidiosis, and other diseases will automatically ward off roundworm infestation.

TAPEWORMS

Tapeworms, in contrast to roundworms, are common in turkey flocks of certain sections of California. The effect of an infestation in turkeys

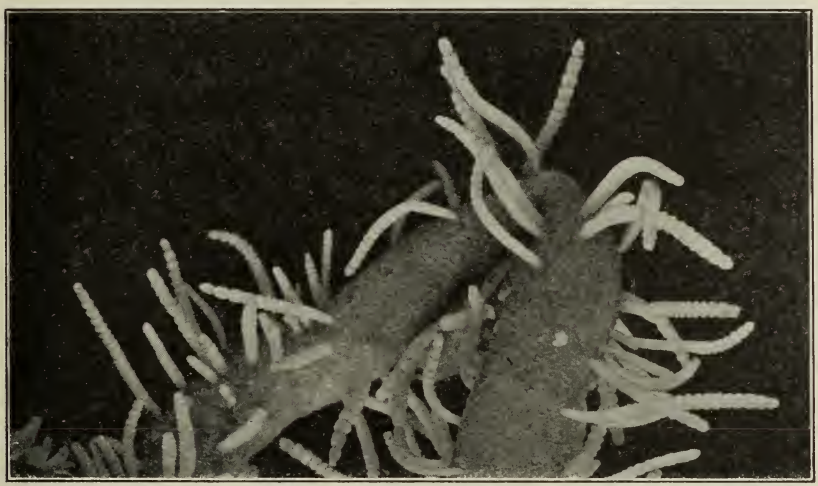

Fig. 58.—Tapeworms attached to inner wall of the intestine (×2). The worms appear somewhat longer and more transparent at the time of post-morten examination. (From Cir. 251.)

is so insidious that the cause is often either not suspected or entirely overlooked. The tapeworm, an inhabitant of the intestines, ranges when full-grown from almost microscopic size to 10 inches, according to the species. It has a "head" or scolex by which it attaches itself to the walls of the intestines (fig. 58). When freshly deposited, the individual segments appear as glistening white, pearly objects, which move about slowly by expanding and contracting. If the eggs are eaten by some other animal, the young tapeworm develops up to a certain stage in the body of this intermediary host, where it remains dormant until the host is eaten by turkeys. Then the larval tapeworm again becomes active and matures, sloughing off more segments full of eggs.

[163] Ackert, J. E., and L. L. Eisenbrandt. On the comparative resistance of Bronze turkeys and White Leghorn chickens to the nematode *Ascaridia lineata* (Schneider). Jour. Parasit. 20(2):129. 1933.

Most of the tapeworms that infest chickens also infest turkeys. Figure 59 shows the scolices, or "heads," of six species. Flies, slugs, dung beetles, earthworms, and snails are common intermediary hosts—an important fact when one is considering methods of preventing and controlling tapeworms.

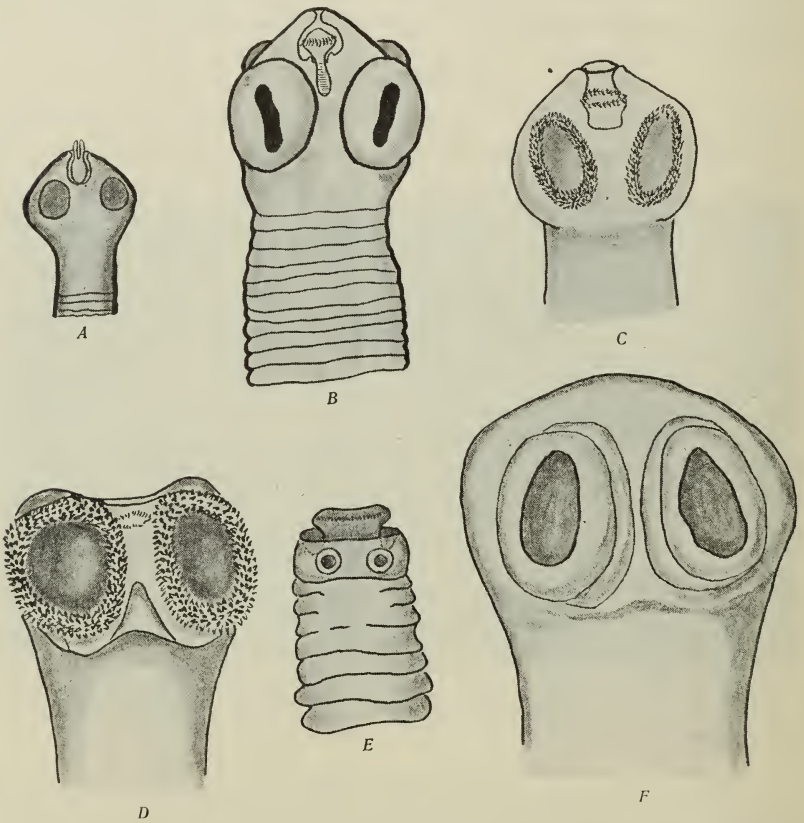

Fig. 59.—Scolices or "heads" of the common poultry tapeworms greatly enlarged but drawn to the same scale: *A, Hymenolepis carioca; B, Choanotaenia infundibulum; C, Raillietina tetragona; D, Raillietina echinobothrida; E, Raillietina cesticillus; F, Metroliasthes lucida.* (From Ext. Cir. 8.)

The common poultry tapeworm (*Choanotaenia infundibulum*) is the species most generally encountered in California turkeys. The intermediate hosts of this species are the housefly (*Musca domestica*) and the dung beetle (*Geotrupes sylvaticus*).

Prevention, Control, and Treatment.—The whole prevention program should be built around a scheme for eliminating, as far as possible, the intermediate hosts of tapeworms. Frequent removal of manure and litter from brooder houses and prevention of heavy fly populations in

turkey-feeding areas will be helpful. Such refuse should be placed in fly-proof storage bins or scattered where flies will not breed. Barnyards or corrals, which are common feeding grounds for dung beetles and flies, should be avoided. As liquid milk and other liquid or semiliquid feeds attract millions of flies, they should not be used if the region is heavily infested with tapeworms.

Control of tapeworm infestation in a flock depends on eliminating the intermediate host and removing the parasites from the primary host, the turkey. Changing the feeding area and at the same time shifting gradually from liquid or semisolid feeds to dry mashes is advisable.

No highly efficient treatment has been developed for removing tapeworms from turkeys. Kamala, often recommended for their removal, is sometimes toxic for turkeys. Recent work indicates that it is not so effective as once thought; therefore its use should be avoided.

EXTERNAL PARASITES

LICE

Lice can be distinguished from all other parasites on the body because they have three pairs of legs and because their bodies, divided into three sections—head, thorax, and abdomen—are flattened dorsoventrally, as if a flattening force had been applied on their backs. They are seldom over $\frac{3}{16}$ inch in length and are yellow or grayish, sometimes ornamented with dark stripes, but never uniformly dark brown or red. Parasites of the latter colors may be fleas, mites, or ticks.

The entire life of the louse, including the egg stage, is spent on the body of the bird. Only by accident do the insects leave their hosts, except to migrate to other hosts of the same species. The eggs require about a week to hatch, after which maturity is reached in about 2 weeks.

At least four species of lice from turkeys have been reported in the United States. The common body louse of chickens, *Eomenacanthus stramineum,* is usually found on turkeys associating with chickens. The shaft louse of chickens, *Menopon gallinae,* has also been found on turkeys; but its presence is probably accidental. The large turkey louse, *Goniodes meleagridis,* and the slender turkey louse, *Lipeurus gallipavonis,* are, in all likelihood, native to the turkey. The large louse is the more common. Rearing turkeys in close confinement and in unsanitary quarters favors lice more than does range rearing. Breeding flocks and especially setting hens are liable to be heavily infested if not treated periodically.

Prevention and Control.—Prevention of lice consists in following the practices already outlined for the prevention of other diseases. In known

infested areas, periodic dusting of the turkeys with sodium fluoride will protect against marked lice infestation. Turkey hens should be dusted before being placed on eggs and again just before the eggs are hatched.

None of the present-day remedies is harmful to the egg of the louse. It is necessary to use a substance that will remain on the body long enough to kill the emerging young or else to give a second treatment between 8 and 14 days after the first.

Sodium fluoride is apparently the only remedy that answers the requirement of eliminating lice in any stage except the egg with a single treatment. It also has the advantages (1) of being safe to both birds and operator, (2) of eliminating the lice completely, and (3) of being suitable for poults and setting hens. Sodium fluoride may be obtained from drugstores as a white powder (commercial form) or as crystals (chemically pure).

It may be applied in any of three ways: the "pinch" method, dusting, or dipping. The pinch method consists of placing on the skin of each fowl approximately 10 pinches (the amount held between thumb and forefinger) of the commercial sodium fluoride, distributed at the following places: on the breast, on each thigh, below the vent, on each side of the back, on the neck, on the head, and finally on the underside of each outspread wing. This is the most effective method of treating turkeys. The birds, when treated, should be held over a shallow pan or newspaper so that any excess of the chemical may be saved. The powdered sodium fluoride is sometimes mixed with 3 or 4 times its bulk of flour or talc and dusted on with a large shaker, the feathers of the bird being ruffled as the chemical is applied. This procedure is less economical and less efficient than the pinch method, and the excess of the chemical in the air is irritating to birds and operators.

The amount of sodium fluoride varies with the efficiency of the person applying the powder and the method used for saving the excess. According to data obtained from growers, approximately 10 pounds of sodium fluoride per 1,000 adult turkeys is required when the pinch method is used.

A dust bath for preventing lice infestation can be made by mixing sodium fluosilicate and fine road dust at the rate of 1 part of the chemical to 3 parts of the dust. New birds should be treated for lice at the beginning of the quarantine period and again a day before being placed with the flock.

Nicotine sulfate (Black Leaf 40) applied to the roosts is an efficient and specific poison for lice; but, under the common California method of rearing turkeys out of doors, it cannot be used efficiently.

MITES

Turkeys are less troubled by mites than chickens are, probably because of the difference in methods of rearing. Occasionally, however, reports of turkeys infested with one of the numerous varieties of mites that attack chickens are received. In practically all such instances, association with chickens or rearing in houses formerly used by chickens is responsible. For detailed information on mites, the reader is referred to a treatise on poultry diseases.[164]

If an old chicken house is to be used for sheltering turkeys, the roosts and cracks in the walls should be carefully examined for the common poultry mite, *Dermanyssus gallinae*. A thorough cleaning of the house and the liberal use of oil sprays will aid in ridding the house of mites. All old nests and rubbish should be removed from an infested house and burned before spraying is started. Paraffin-oil emulsion is a very effective spray for killing ticks, mites, and certain other external parasites which hide in the cracks and crevices of poultry houses at least during a part of their lives. It is prepared by first dissolving 1 pound of soap in 10 quarts of water. After the soap has dissolved, the solution is removed from the fire and allowed to cool to a lukewarm temperature. Then 10 quarts of paraffin oil is added to the soap solution and thoroughly stirred until the liquid becomes creamy. This constitutes the stock solution. The finished spray is made by diluting 1 part of the stock solution with 6⅓ parts of water.

The scaly-leg mite, *Cnemidocoptes mutans,* occasionally causes the characteristic scaly leg in turkeys. This mite burrows beneath the scales of the leg; its presence and activities cause a lifting of the scales and a swollen condition of the shank which, in advanced cases, result in such distortion and deformity that the affected birds cannot walk. It is seldom seen except in old birds.

Treatment consists in dipping the legs of the birds in a mixture of equal parts of crude oil and raw linseed oil, taking precautions to avoid wetting the legs above the scaly portion. After 3 weeks, unless marked improvement is noted, the treatment should be repeated. This, however, is seldom necessary. The legs of newly acquired birds should be carefully observed in order that infected birds may be segregated and treated before being placed with the clean flock.

TICKS

Although ticks molest turkeys, heavy infestations are rare unless turkeys are reared in old tick-infested chicken yards or houses. The

[164] Beach, J. R., and M. A. Stewart. Diseases of chickens. California Agr. Exp. Sta. Bul. 674:113–21. 1942.

ticks, though closely related to the mites, are always larger, being easily visible to the naked eye, and have a thick, leathery cuticulum or skin.

The only tick of economic importance that attacks fowls is the so-called "fowl tick" or "blue bug," *Argas persicus*. The adult tick is flat, egg-shaped in outline, dark brown in color, from ¼ to 7/16 inch in length and about half as wide at its widest part. Its habits are essentially like those of the common chicken mite. It has a remarkable ability to live for long periods without food. Records are available of adult ticks that have fasted for two and a half years.

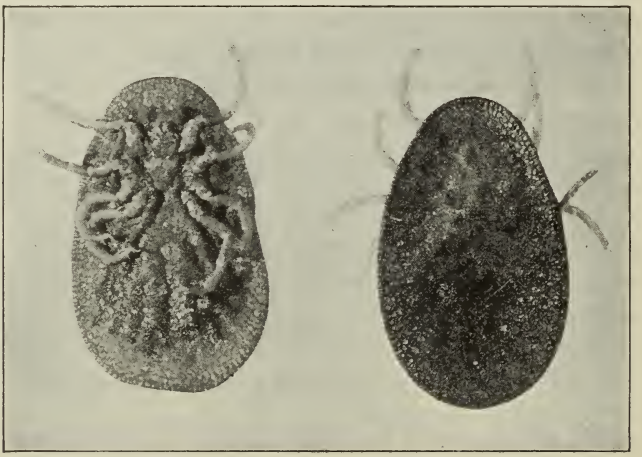

Fig. 60.—Ventral and dorsal view of the poultry tick, or blue bug, enlarged. (From Cir. 251.)

Prevention, Control, and Treatment.—Turkeys that have been purchased for replacements, or birds that have been temporarily removed from the flock for loan or show purposes, should be carefully inspected for ticks (fig. 60). Thighs, breast, and sides should be examined for the roundish, bluish-red, larval ticks, which are easily seen because of the contrast in color between their bodies and the birds' skin. Chickens and other fowl brought on the premises should also be inspected. The usual quarantine procedure recommended for the prevention of other diseases should be observed.

Treatment is the same as for the common chicken mite except that the spray material should usually be stronger when the dilution is made with water. The paraffin-oil emulsion given above is an effective spray material for ticks as well as mites. Sometimes individual fowls show signs of weakness when heavily infested with larvae which are taking a first meal and which remain attached for several days. Such birds

should be immersed in a 2 per cent coal-tar dip. The usual practice, however, is merely to segregate the infested birds for a few days in an isolated coop until the ticks become engorged and drop off. Then the birds may be returned to the flock, and the coop destroyed or disinfected.

ADDENDUM

Since submittal of the original manuscript for the revised edition, several diseases not previously reported in California have been diagnosed. Although not yet important causes of mortality, they may become of economic importance.

Avian pneumoencephalitis, a newly described disease of chickens, has been found also to cause losses in turkeys in a few instances. The disease is described in Bulletin 674 (cited in footnote 164, p. 133).

The tropical fowl mite, Liponyssus bursa (see Bulletin 674, cited in footnote 164), was recently diagnosed by us in a flock of turkeys in southern California. The symptoms and effects on the turkeys are identical with those seen in chickens. This mite lives its entire life history on the body of the host. Control measures are the same as described for lice (p. 130).

A blood parasite apparently identical with *Leucocytozoon smithi,* which causes severe losses in the southeastern United States, was recently identified by us in turkeys from four ranches in northern California (Hinshaw and McNeil, unpublished data). This protozoan spends a part of its life cycle in another host, the most common one being black flies of the genus *Simulium,* which sometimes feed on turkeys. Complete segregation of breeding and brooding operations, such as is suggested for controlling hexamitiasis (p. 97), will do much to prevent this disease.

Lymphomatosis (see Bulletin 674, cited in footnote 164) is being diagnosed with increasing frequency in the state. The visceral type is the only one so far observed by the writer, and the liver appears to be the organ most commonly affected. There is no cure.

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